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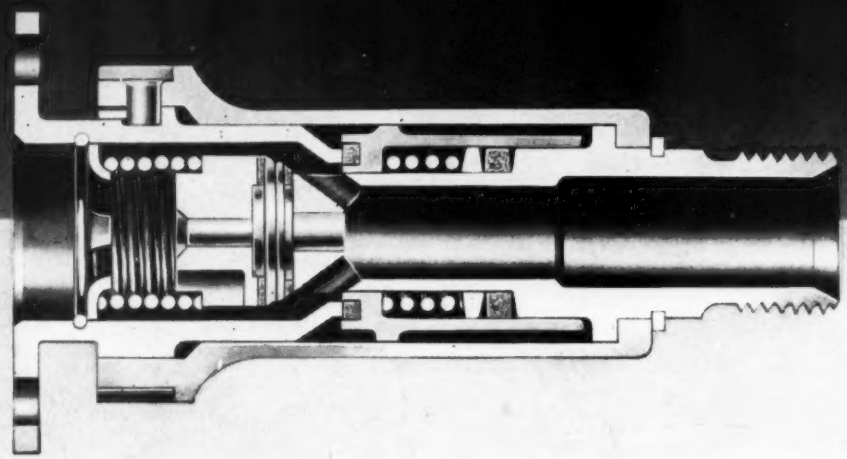

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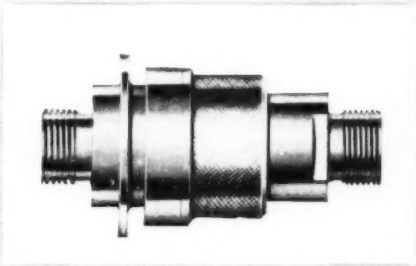

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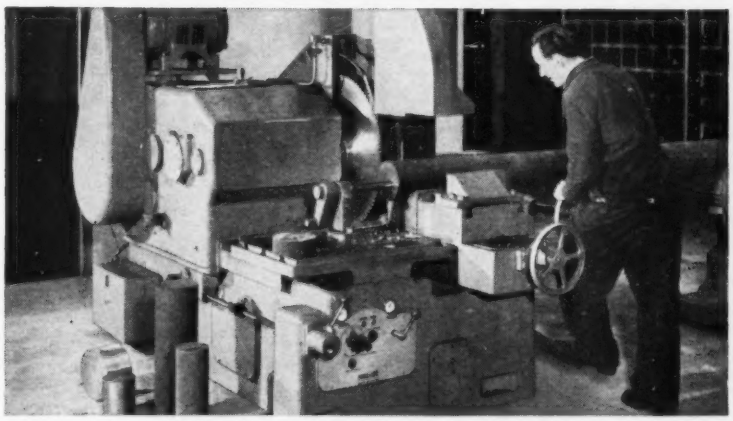

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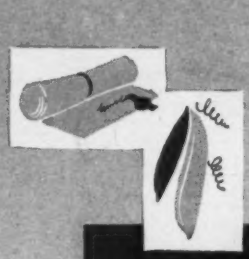

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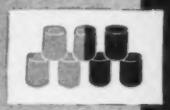

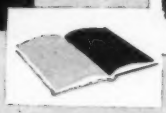

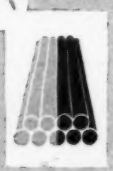

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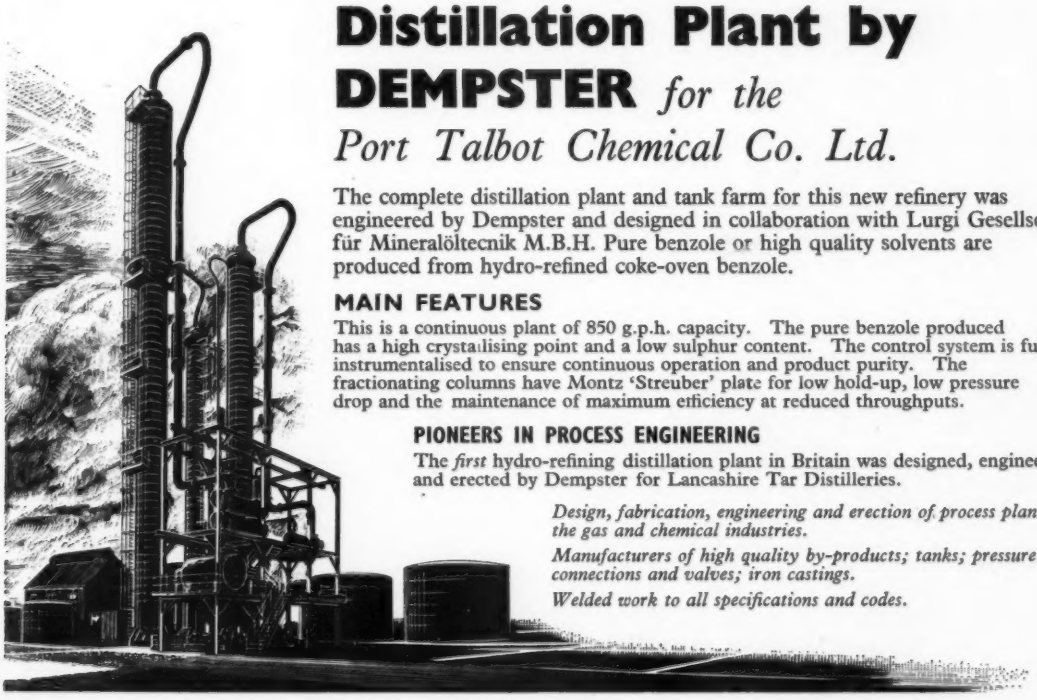

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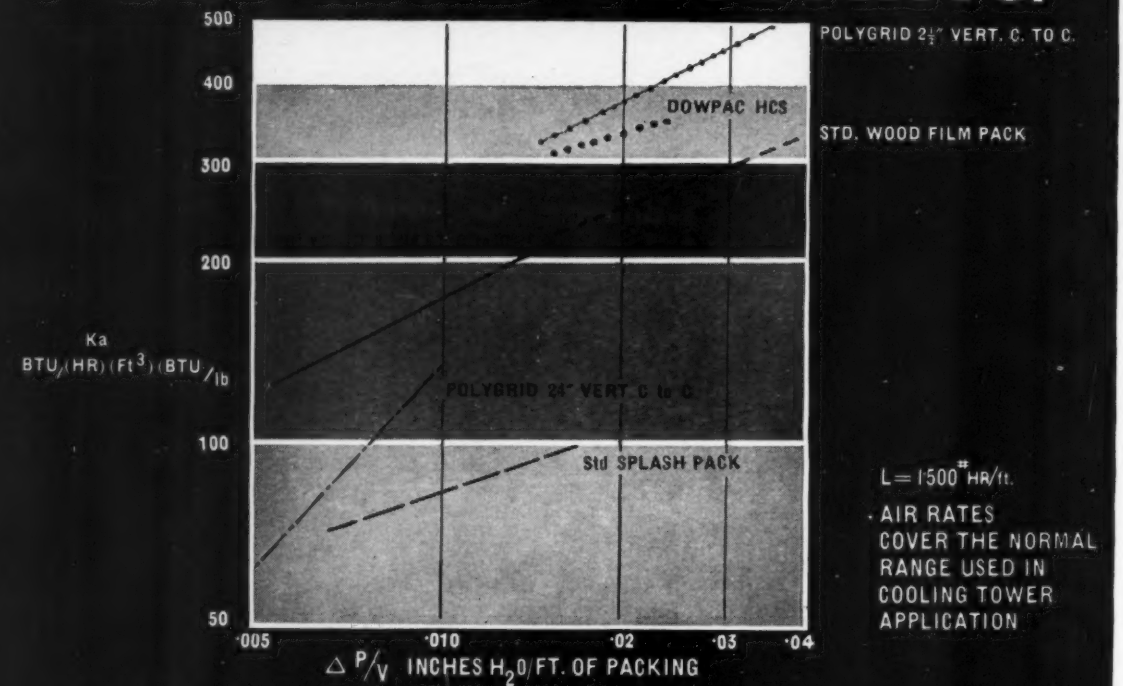

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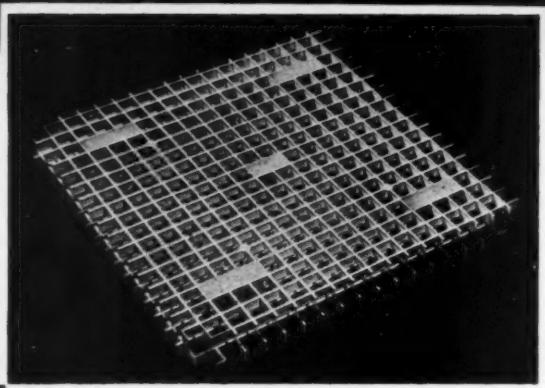

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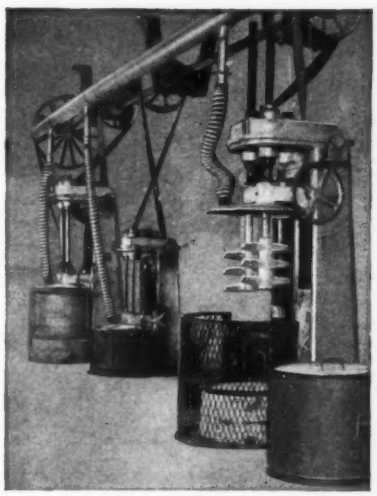

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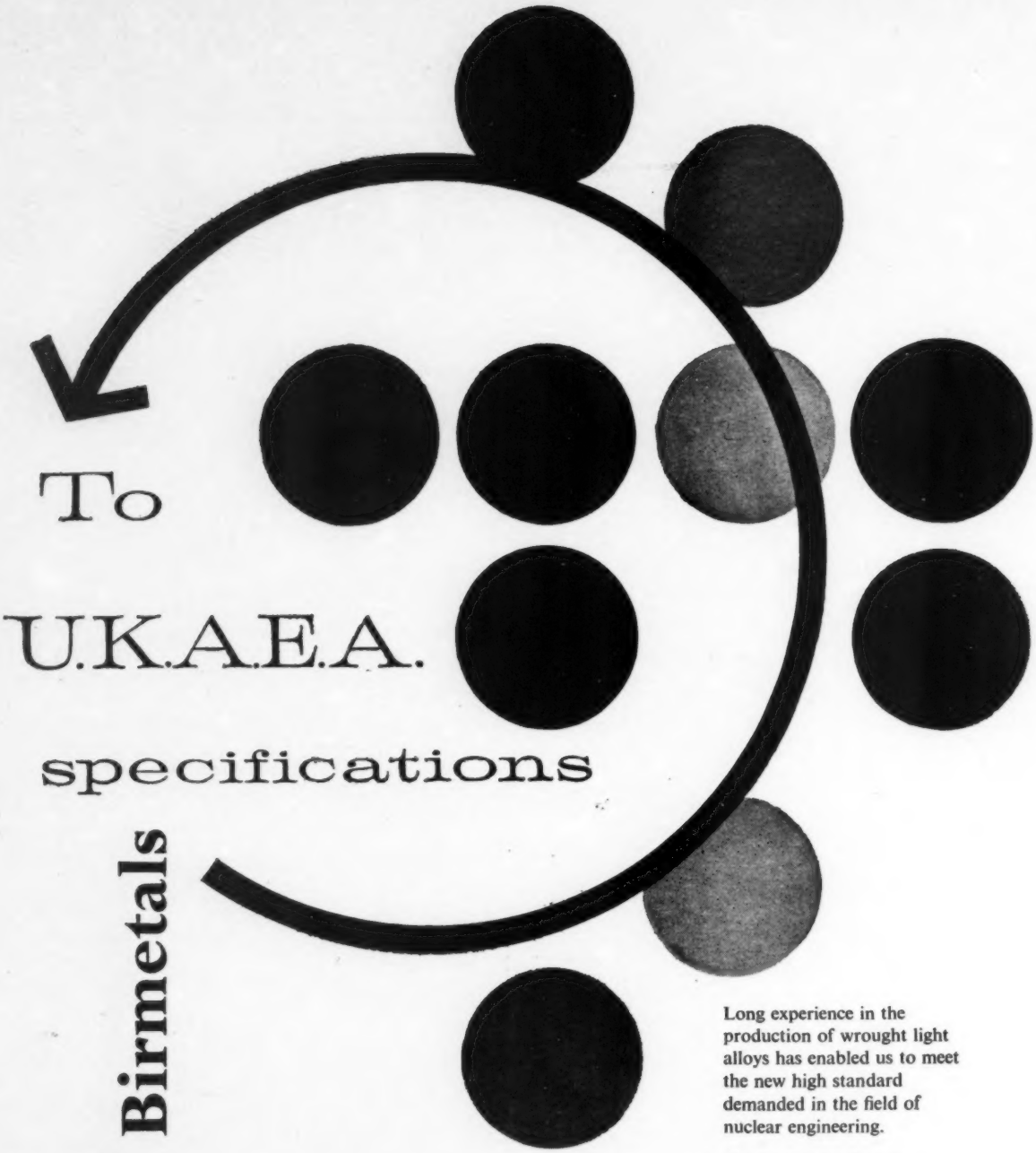

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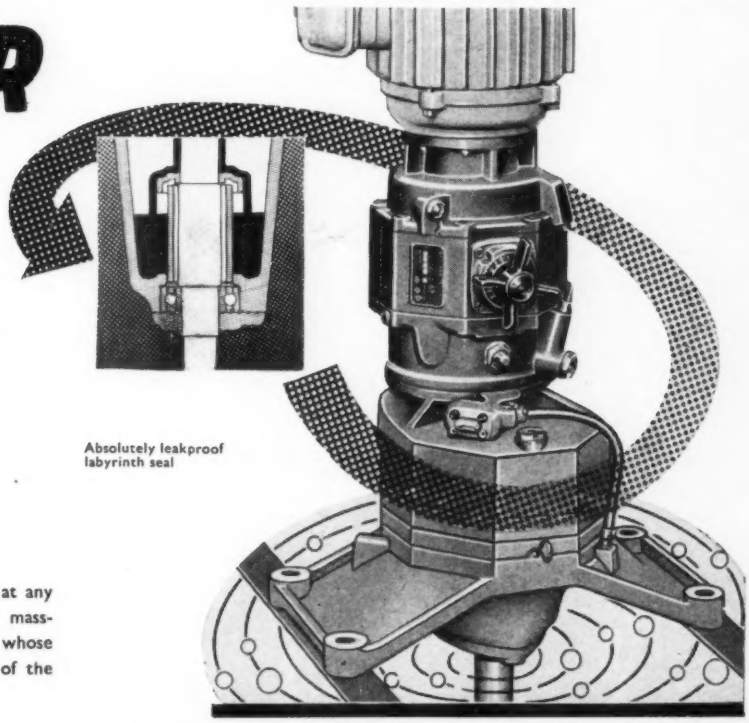

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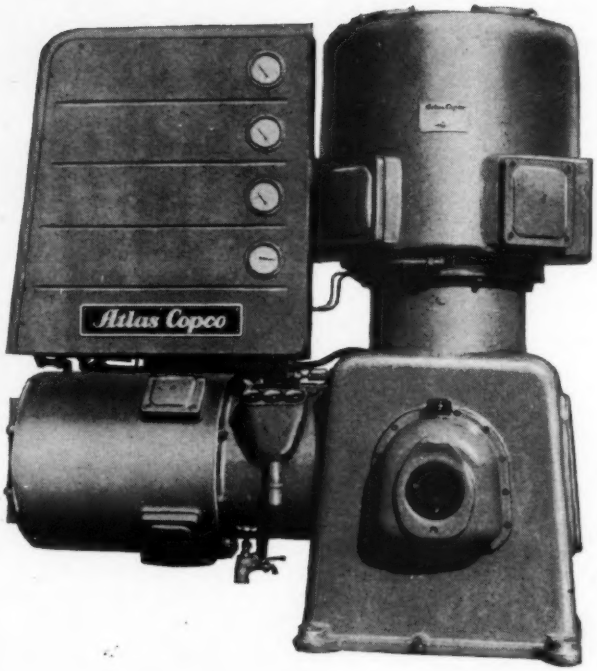

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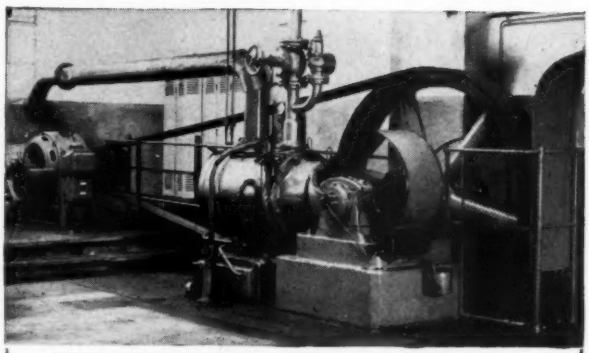

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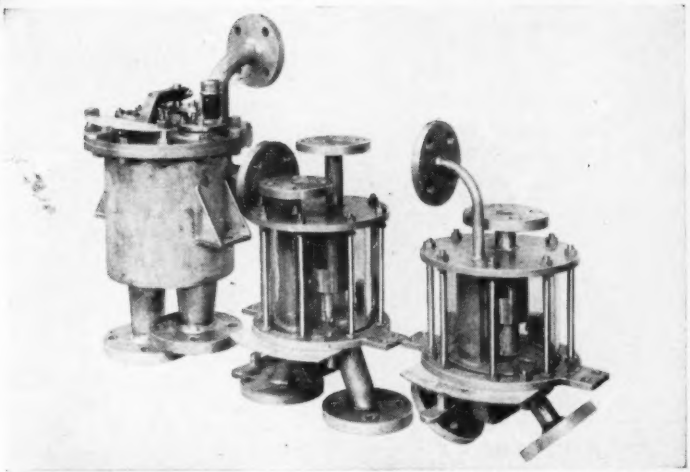

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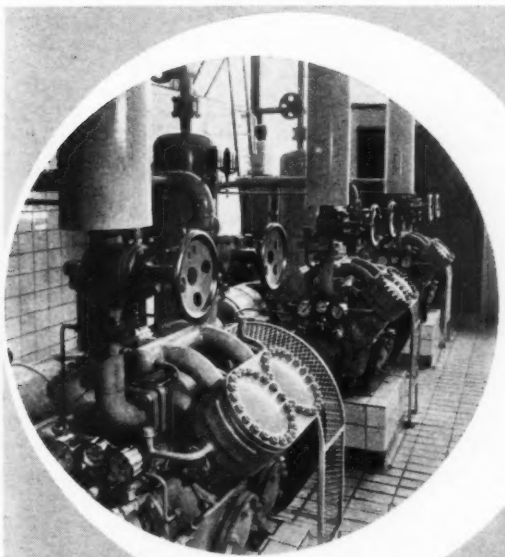

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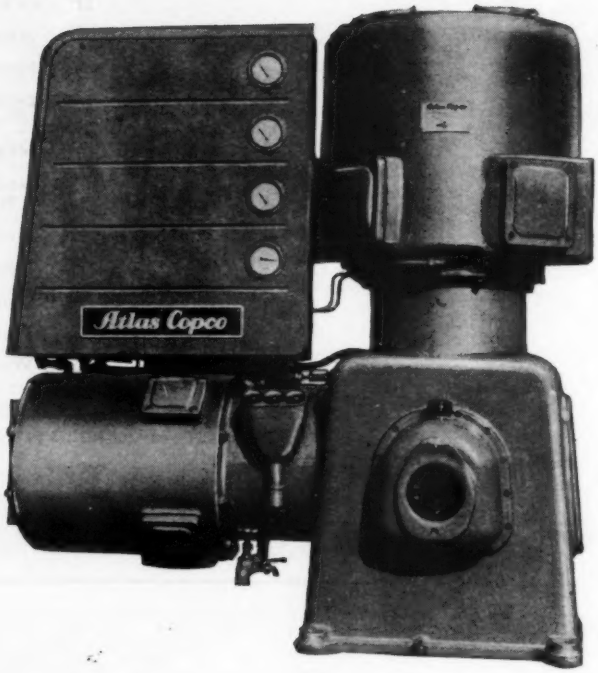

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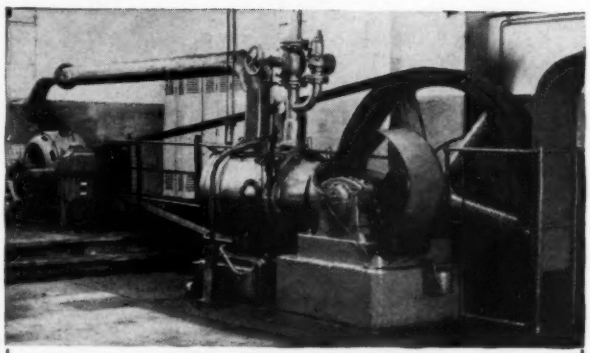

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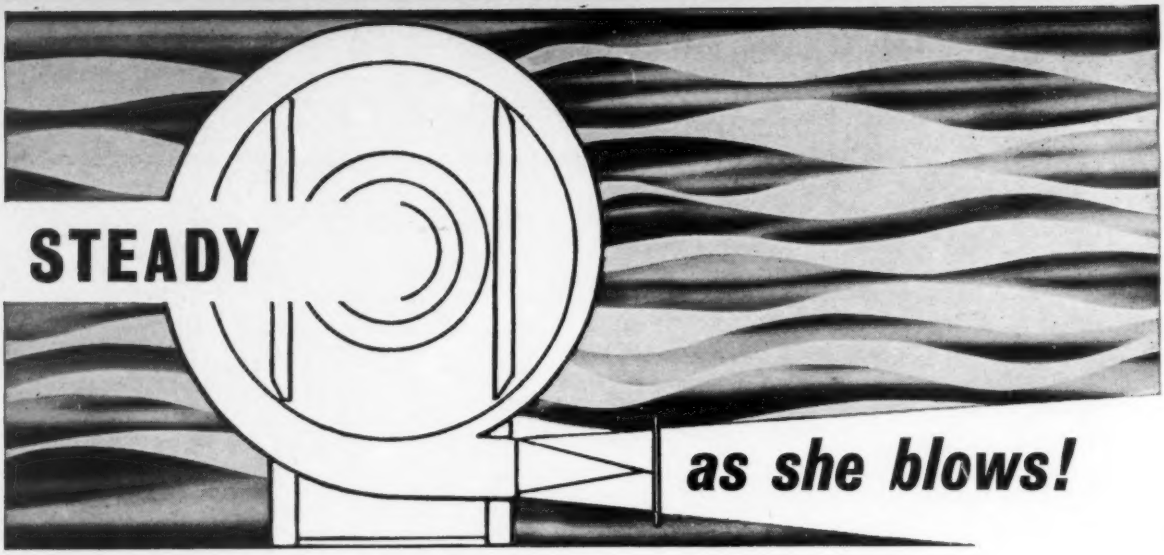

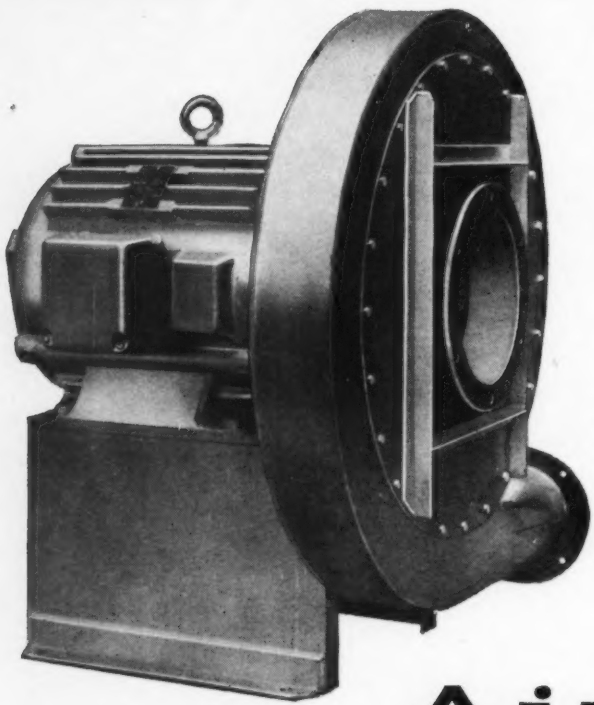

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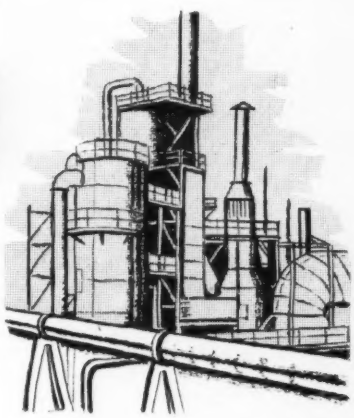

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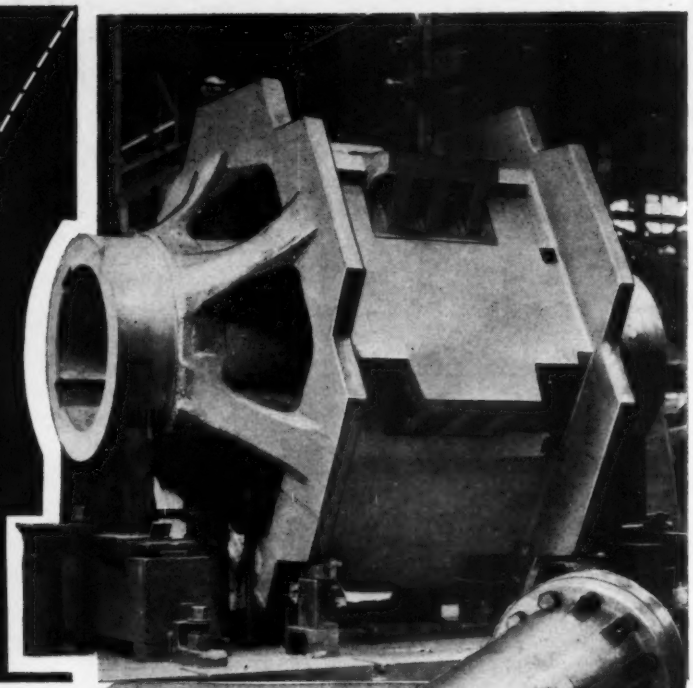

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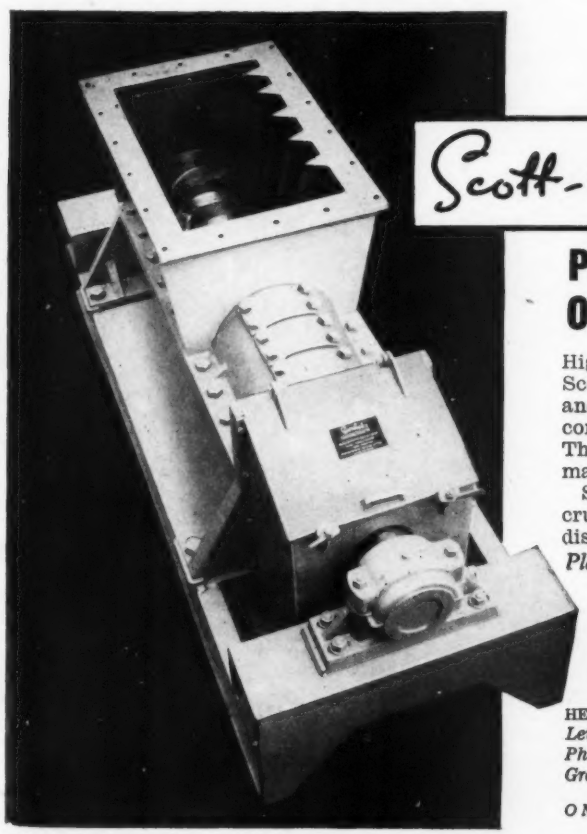

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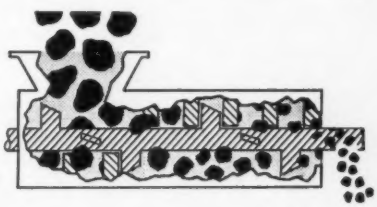

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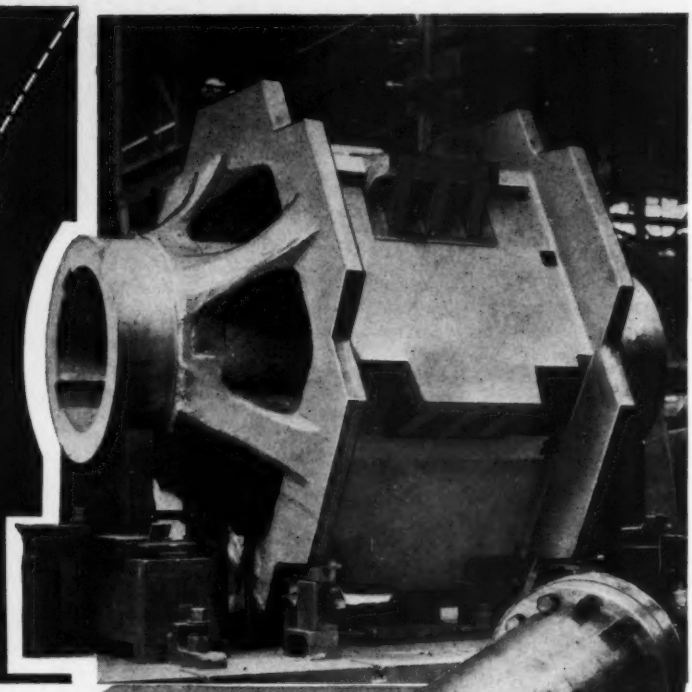

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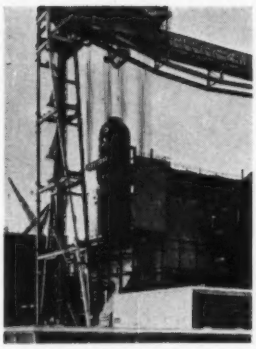

Complete section of a reactor vessel for Hinkley Point station being lifted into the biological shield by the 400 tons capacity Goliath *crane.*

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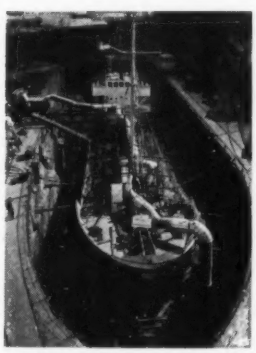

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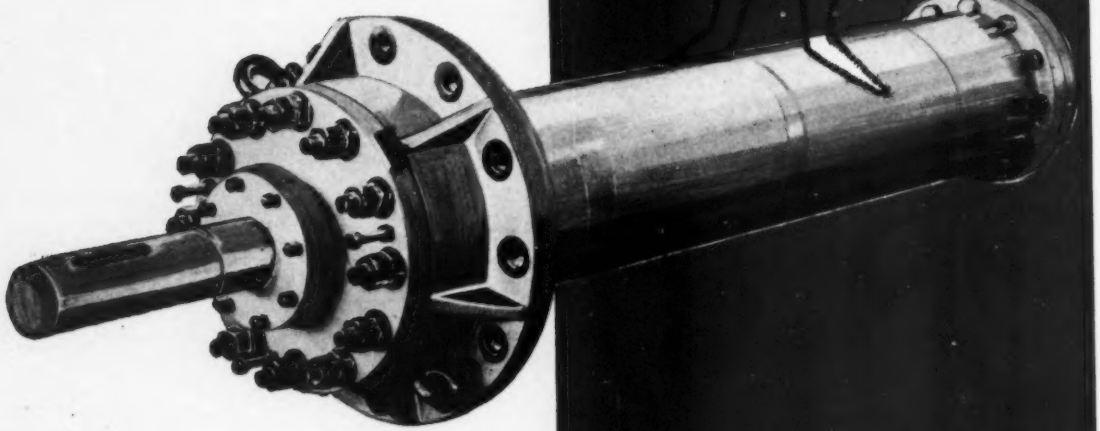

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CPE
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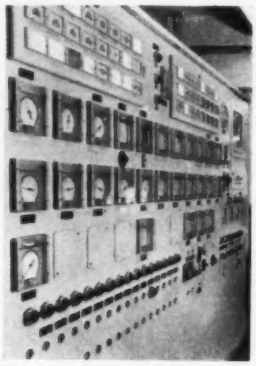

The main control panel for a pilot plant of a pressurised slagging coal gasifier. The instrumentation of this plant is described in an article forming part of a special feature on instrumentation for process control.

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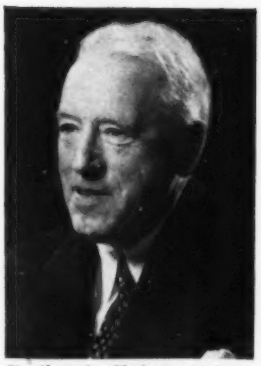

Sir Alexander Fleck, K.B.E., F.R.S., is to open the Corrosion and Metal Finishing Exhibition on November 29, at Olympia. A preview of the exhibition appears this month.

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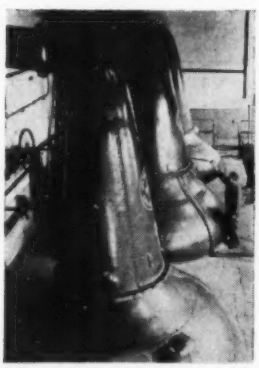

Whisky stills made of copper show one of the uses of copper as a material of construction for chemical plant.

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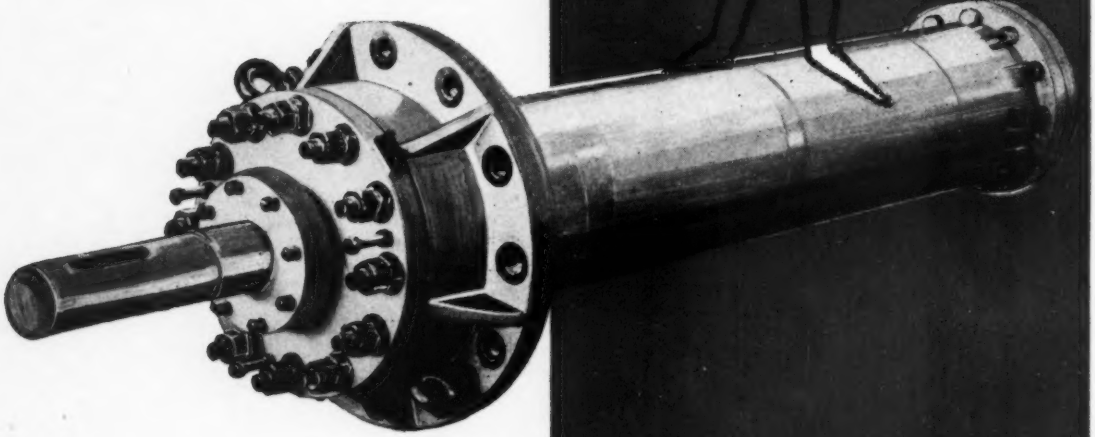

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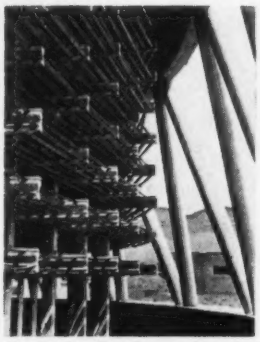

The interior fill of concrete cooling towers has always been made of timber and a large quantity may be used in a single tower. Timber as a material of construction for chemical plant is discussed on

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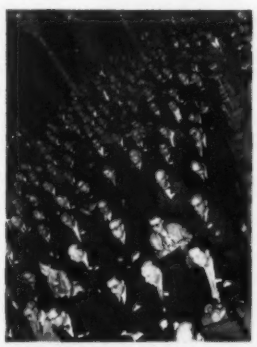

European and American chemists and chemical engineers met recently in Barcelona at the 32nd International Congress of Industrial Chemistry. A full report appears on

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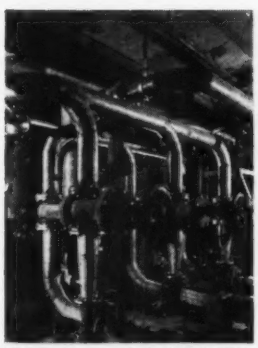

The pump room of the MELUSINE pool-type research reactor. This reactor, which has been in operation at the Centre d'Etudes Nucleaires in Grenoble since 1958, is described in an article on

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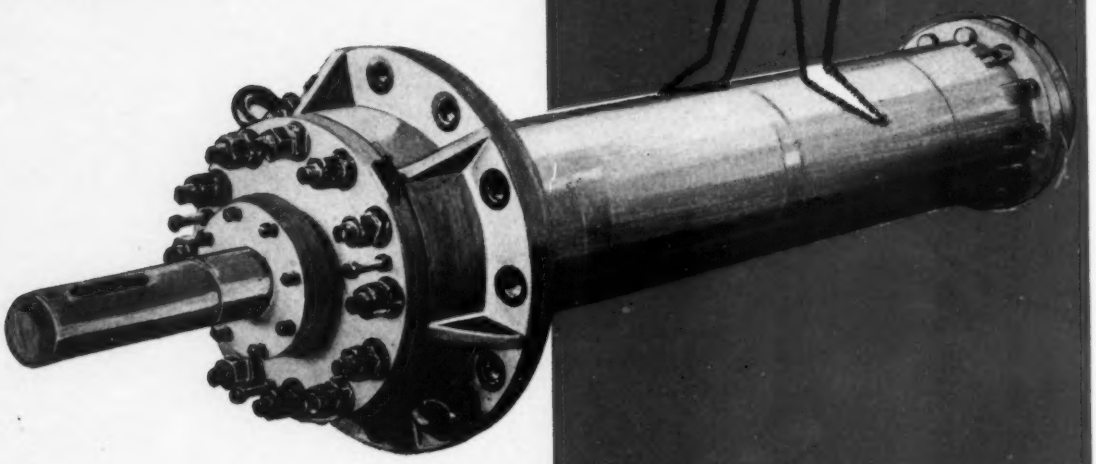

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TOPICS OF THE MONTH

India's new steelworks

THE ceremony which took place at Durgapur, West Bengal, recently marks not merely the commissioning of the first blast furnace but also the inauguration of a great integrated steelworks which includes a complete coke-oven and chemical by-products plant.

It is also the climax of a prodigious effort by 13 British firms, some of them normally fierce competitors, who joined forces as a consortium called the Indian Steelworks Construction Co. Ltd. to carry out this £105-million contract for Hindustan Steel Ltd. The contract represents the biggest export order ever obtained by British industry, and an outstanding achievement in Indo-British co-operation, some 50% of the capital expenditure and tonnage of raw materials being supplied by India herself. Of the 33,000 site workers the vast majority are Indian; this includes a high proportion of skilled Indian supervision.

Financing of the project involved co-operation at an even higher level, for the British Government arranged a loan of £15 million to the Indian Government while several British banks got together and produced a letter of credit for a further £11½ million.

Finally, it is worth noting that international competition as well as international co-operation has played some part in the success of this project so far, for of the two other big steelworks projects being undertaken in India, one at Bhilai is being undertaken by the Russians and the other, at Rourkela, by the Germans.

The Durgapur steelworks has a rated capacity of 1 million ingot tons p.a., while the coke-oven plant will yield impressive tonnages of blast-furnace and other cokes. The daily output of coke-oven by-products will include 57 tons of bagged sulphate of ammonia, 156 tons of crude tar, 6,240 gal. of benzene, 884 gal. of toluene, 182 gal. of xylene and 146 gal. of solvent naphtha.

The iron-making plant at Durgapur was designed by Head Wrightson Iron & Steel Works Engineering Ltd., a subsidiary of Head Wrightson & Co. Ltd., who are members of the Indian Steelworks Construction Co. Ltd. Each of the three furnaces is capable of a daily material production of 1,250 tons of iron, with an estimated average consumption of 2,000 lb. of coke and 700 lb. of limestone per ton of iron produced. Two of the furnaces will normally produce iron for steel-making, while the third, when available, will be producing foundry iron for consumption in the works foundry, or for sale.

All equipment is designed to enable the furnaces to be operated at a later date at a high top pressure of 10 p.s.i. Each furnace has a hearth diameter of 27 ft. with 18 tuyeres and an effective working volume of approximately 41,400 cu. ft. Hematite iron cooling plates inside the hearth jacket provide the cooling.

The estimated total gas made from three furnaces will be 18 million cu.ft./hr. and the gas-cleaning plant is designed to clean this quantity to a maximum dust content of 0.004 grain/cu.ft. After passing through the primary and secondary dust catchers of the two static tower gas washers, the washed gas from each of the three furnaces is then passed into an electrostatic fine cleaning plant common to all three furnaces. This will consist of eight Head Wrightson Research Cottrell wet tube electrical precipitators, each 25 ft. in diameter with 400 8-in. tubes.

A new source of chemicals

AMONG the projects mentioned in the latest annual report of the National Research Development Corporation is the scheme for producing acetylene by partial combustion of methane. The development of this process, which was started at Imperial College, London, has been transferred to a small laboratory set up by the Corporation at the Mogden drainage works of the West Middlesex County Council, where continuous supplies of methane are available from sewage processes. A burner system has been developed which gives higher concentrations of acetylene than those obtained in current industrial practice. The process could provide a rich new source of organic chemicals and its commercial exploitation is being explored with a number of manufacturers.

A new N.R.D.C. project is an automatic apparatus for the chemical treatment and scanning of chromatograms, invented by Dr. I. E. Bush of the Radcliffe Infirmary, Oxford. His prototype instrument is nearing completion.

Nearly 700 inventions were communicated to the Corporation during 1958-59 and 187 patent rights were assigned to them, both figures being somewhat higher than in the previous year.

Sulphur from smelter gases

ENCOURAGING results have been obtained in eight months' operation of a pilot plant for obtaining pure sulphur from sulphur dioxide as a by-product of iron-ore recovery operations. This has been jointly announced by the Texas Gulf Sulphur Co. and the International Nickel Co. of Canada Ltd., who have both been concerned with the $500,000 pilot plant set up at Inco's Sudbury, Ontario, iron-ore plant. The nearness of the Great Lakes makes it possible to transport sulphur to eastern Canada and other large consuming areas at low cost; however, whether large-scale commercial production will be worth while depends on costs, as projected from further pilot operations, and also on the future price of sulphur.

Sulphuric acid and liquid sulphur dioxide are now being produced in quantity from Inco smelter gases but, because of storage and shipping limitations for

these products, it has not been possible to market all the sulphur available from such gases. If elemental sulphur can be produced economically from smelter gases, maximum flexibility of storage and transportation will be achieved.

The sulphur is extracted by reacting high-quality sulphurous gas with a chemical reducing agent at high temperature over a specially developed catalyst. Among the three satisfactory reducing agents, natural gas (now available at Copper Cliff) has some technical advantage over propane gas or fuel oil, but selection will remain flexible in the light of cost.

Priorities awry

IN 1870 a gentleman called Mark Pattison complained that the universities could not find any more students worth educating—there were then fewer than 5,000 undergraduates in Britain. It seems that this view still prevails, for only 6% of our schoolchildren are deemed fit for a university education compared with 35% of American children. An American child is three times as likely to go to a university as an English child is to go into a sixth form. Of course, our university authorities set higher entrance standards than the Americans. In some American universities 40 to 50% of students fail and leave after the first year. Even a fraction of this failure rate would horrify our universities. But the Americans still think that a year in a university is of value even to a man who cannot stay the pace. Their system may be relatively extravagant and inefficient, but it is extremely effective and productive because of the sheer number of students who go to universities.

This is one of the points made by Dr. B. V. Bowden, Principal of Manchester College of Science and Technology in an indictment of Britain's comparative neglect of university development in an article in the *Universities Quarterly*. If we reach our target of increasing the number of university students to 150,000 by 1970 we shall still have fewer students in universities than France, West Germany and Italy have *today*. In a list of 27 countries we are fourth from the bottom in terms of the number of university students per million of population. Only three countries—Ireland, Turkey and Norway—have fewer students per million than Britain. Our figure is 1,815 per million, less than half that of 16 countries, including —apart from the obvious instances of Russia and the U.S.—Argentina, Poland, Bulgaria and Australia. Even if the U.K. figure is doubled by including students at technical colleges, we still have fewer students per million than 16 other countries.

If we are so backward in providing university education, how is it that we are more prosperous than so many of the countries with better educational facilities. The answer surely is that we are still living on the accumulated fat of a century of industrial and technological dominance. The momentum provided by the great Victorians still carries us along. But what are we doing to regenerate this onward movement? We spend £37.3 million on university grants and £47.6 million on the egg subsidy. Eggs are more important than eggheads, apparently. We spend £557 million on the Health Service to treat disease and a miserable £3.1 million on the Medical Research Council to find out how to treat and prevent disease.

Ethylene is the yardstick

THE rapid growth of the British petrochemical industry is certainly to go down in history as one of the major developments of the past decade, certainly as far as the chemical engineer is concerned. Whether it be plastics, synthetic rubber or synthetic fibres, it is of interest to note the value of one single raw material, namely ethylene, whose output can be safely used as a yardstick of the mounting importance of this industry.

The overwhelming majority of ethylene production is oil based, coming from the pyrolisis of ethane, propane, or light liquid fractions such as naphtha and gas oil. About 200,000 tons of ethylene were produced in Britain during 1959, compared with 90,000 tons in 1954. The major U.K. producers are Imperial Chemical Industries, British Hydrocarbon Chemicals, Shell Chemical and Esso Chemicals, who between them have an estimated capacity of 250,000 tons/yr., scheduled to be increased to about 350,000 tons/yr. by 1961.

Whilst this basic raw material, ethylene, is often thought of simply as a by-product of the refining industry, this is true only to a very limited degree. The amount which is available in this way is by no means adequate to meet demand—a cat cracker for example, produces only about 20 tons of ethylene a day. Consequently it is necessary to make ethylene by direct cracking, involving highly expensive equipment, like the £9-million plant now being built by British Hydrocarbon Chemicals at Grangemouth, which will produce 70,000 tons/yr. of ethylene.

The four most important intermediary products that ethylene is turned into *en route* to its many end-products are polythene, ethyl alcohol, ethylene oxide or styrene. The most important use of ethylene is its polymerisation into polythene plastic. Polythene, invented by I.C.I. in the 1930s and first produced in Britain in 1939, has taken a leading role in the field of plastics both in Britain and abroad, particularly since the war. About 70,000 tons of it were made in the U.K. during 1959, and the industry's capacity is rapidly increasing; the most recently opened plant in Britain belongs to Monsanto Chemicals, is situated at Fawley, and will make 10,000 tons/yr. of polythene when fully on stream. Demand for polythene has risen in recent years at a rate of 15 to 20% a year.

The advent of a whole new technological field, following the development of low-pressure Ziegler polythene, vastly increases the future importance of ethylene in the field of plastics. Competitors will certainly appear—based perhaps on other olefins, such as propylene, which is at present much more abundant than ethylene—but it will be some time before ethylene is displaced from its position as the most important raw material in the rapidly growing petroleum chemical industry.

Plastic bubble caps

THERMOSETTING plastics are now under trial as a constructional material for distillation and treating towers. Results of tests that have been carried out in the United States would indicate that they may soon offer strong competition to pressed carbon and even metals in uses where corrosion resistance is important.

One such company pioneering this new use for plastics is Wyatt's Plastics of Houston, Texas. They are already turning out thermosetting plastic bubble caps and risers and later plan to include plastic trays, downcomers and other distillation and treating tower assemblies in its line. The bubble caps and risers were tested in one of America's leading refineries and it was found that, after one year in a tower contacting 55 to 65% sulphuric acid at 340°F., the parts showed no corrosion or other ill effects.

Bubble caps and risers made from plastic will cost less than those made from conventional material because they can be moulded, while other materials require machining. It is stated that the tensile strength of the plastic developed by this American company is about 5,000 p.s.i. and greater than that of pressed carbon.

The company is at present producing plastic bubble caps and risers in sizes up to 8 in. diam. Production in larger sizes is contemplated.

How Ford re-use water

WATER softening and desalination must be one of the oldest headaches in chemical engineering and, although 'new' techniques are frequently patented, the central core of the problem remains: the economical large-scale treatment of supplies containing excessive amounts of sodium chloride, or the removal of calcium carbonate and other salts from industrial supplies for various specialised purposes. Recently there has been added to this also a considerable demand for completely deionised water for washing delicate electronic components such as transistors, which are now produced in very large quantities.

However, progress is being made with design of economical water-treatment plants on an industrial scale. This is proved by that fact that it is now used even in metal-working factories. When the Ford Motor Co. built their new painting and trimming shops, they found that it paid them to install a Permutit plant and recirculate the treated water used for washing the car bodies before painting, rather than face the increasing water supply difficulties and costs involved in a daily consumption of some 400,000 gal., and put up with the streaky marks left behind by the mains water as well. The latter consist of hygroscopic salts which impair the quality of the finished paintwork.

The plant has a normal output of 23,000 gal./hr. of reclaimed and 6,300 gal./hr. of demineralised water. The former is produced by flocculation, sedimentation and filtration, as a result of which solids and bacterial contamination are both eliminated. The waste water is dosed with lime, chlorine and ferrous sulphate. Coagulation is assisted by two paddle wheels.

The demineralised water must not contain more than 23 p.p.m. of total solids with a *p*H value of 5 to 6. To achieve this, the filtrate is blended with mains water to compensate for sludging losses and then subjected to a two-stage ion-exchange process. The columns are arranged in two parallel pairs so that periodic regeneration does not interrupt the supply. The first pair, containing a cation resin, convert the salts into acids; the second, anion columns, absorb the acids. For degassing, the partly treated water is allowed to fall through a tower packed with porcelain rings which provide a reaction surface. Air introduced at the bottom picks up the CO_2 and vents it to the atmosphere.

It is claimed that the financial savings of this plant will cover its cost in 30 months. With industrial water supply getting shorter every year it will pay the managers of many types of chemical and process plants to look into this question of recirculating water.

It pays to keep down pollution

IN these days of chemical and atomic effluents and decreasing water supply, every newly developed process must be scrutinised almost as much from the point of view of river and air pollution as from that of economy. Fortunately, the two considerations are rarely incompatible and, in the case of a new sodium-base pulping liquor recovery process, one follows directly from the other.

The American chemical cellulose producer Rayonier is converting its Grays Harbor, Washington, sulphite mill from ammonium base to the new sodium process from which, it is claimed, at least 85% of pulping chemical will be reclaimed. This will lead to a considerable reduction of mill effluent and, in fact, the Washington State Pollution Control Commission has now granted a permanent permit for pulping operations at the Grays Harbor site, presumably because of the reduced effluent pollution resulting from the new technique.

The process itself contains several elegant features, notably recovery and recycling of spent liquor from the present blow-pit washing system, the removal by electrostatic precipitators of all dust particles from the stack gases, and the utilisation of hydrogen sulphide produced in the carbonisation step as a fuel to refine molten sulphur which, in turn, will be burned in sulphur burners for the preparation of cooking liquors. This will be mixed with a solution of sodium bisulphate in sulphuric acid.

For recovery of spent liquor from the digestion stage, it will be stripped with steam and neutralised with caustic soda. After filtration it will be concentrated in evaporators. The inorganic solids in the liquor will be reduced to a smelt, cooled and fed as a slurry to an extraction column where the sodium sulphide can be leached out and the carbonate recovered for carbonisation.

It is not yet clear whether this new and flexible process will lead to any significant price reduction in

cellulose products, but if it does it will be a matter of considerable importance to importers in the United Kingdom who may face a reduction in their supplies from European sources, as a result of the 'Outer Seven' Free Trade Area which will open this country to the finished products of Scandinavian manufacturers.

In any case it is a process which is typical of the advanced techniques being developed today, in that it uses up the maximum amount of process chemicals instead of throwing them away to pollute a river or the atmosphere.

Lament for a gasworks

CHEMICAL engineering has come to gas manufacture in a big way and the increasing trends towards big, integrated gas and by-products plants, the inevitable adoption of modern, efficient gasification methods such as the Lurgi and O.N.I.A.-G.E.G.I. processes and, now, serious talk of a 'national grid,' has spelt the death of the small, antiquated gasworks which produced town's gas for rural areas. The passing of these quaint, fascinating little works is as painful to the sentimental student of gas industry history as diesel engines and electrification are to the railway enthusiast.

In the West Country, for instance, there used to be a tiny gasworks where the manager and his family were wont to spend their Sunday mornings sitting on top of the solitary gas-holder—so that their weight would increase the gas pressure and the local inhabitants would have an adequate supply of gas for cooking the Sunday dinner! Who would dare to say that such installations as this were not at least as romantic as any Puffing Billy?

The latest cruel blow to gasworks antiquarians is the closing down of the South Staffordshire Mond gasworks at Dudley Port, which used to supply ammonia for Ludwig Mond's ammonia soda process. A low-calorific gas, useful as an industrial fuel was an important by-product and it was Mond's claim that it was the first works in the country to supply gas to factories for purely industrial purposes. To do this, Mond had to fight a legal battle with other gas suppliers (of ordinary town's gas) in the area, a battle which ended in triumph for Mond with the passing of the South Staffordshire Mond Gas Bill. The value of Mond's 'audacious' experiment is today acknowledged in the harmonious production of both town's gas and power gas by a nationalised gas industry, and the extent to which power-gas production plant and processes have been developed and brought up to date by the Power-Gas Corporation.

The old Mond gasworks has been closed down because the West Midlands Gas Board's new £8-million Lurgi plant at Coleshill in Warwickshire makes it redundant, and because it is showing signs of cracking up with old age. Yet the works has the proud record of having kept up a continuous supply of gas for over half a century and—ironically, in view of its inventor's country of origin—the only interruption was caused by a German bomb in 1941.

Electro-hydraulic crushing of coal

AN electro-hydraulic method of pulverising coal has been developed in the U.S.S.R. It is said to yield a product of extremely fine particle size. The essential features of the process as developed at the Mineral Fuels Institute of the U.S.S.R. Academy of Sciences, are the passing of a continuous succession of high-voltage transient electrical discharges through a tank of water, to produce what is described as extremely high hydraulic shock pressure (around 100,000 atm. or more), accompanied by intense cavitation and intense ultrasonic emission.

The electrical discharge forms a spark channel which expands rapidly and a considerable cavity is formed which immediately collapses, the cycle then repeating itself. A region of high pressure is formed around the channel through which the spark passes and within this region there are a number of zones which, in varying degrees, are capable of disintegrating or changing the mechanical properties of minerals or metals placed in them.

Reporting on this development in *Vestnik Akademii Nauk S.S.S.R.*, 1959, (6), 62-65,* B. I. Losev and his co-workers claim that crushing to any desired particle size can be effected, and that coal of any size can be treated without any preliminary preparation. When Moscow brown coal was crushed in the laboratory mill the crushing was so fine that the particles passed through an ordinary filter paper (pore diameter 3.5 to 10μ). The coal was so reactive that it ignited spontaneously in the drying oven even at 80°C. No spontaneous combustion in the seam has been observed.

It is known that ultrasonic vibrations bring about a number of chemical reactions, the majority of which proceed only in the presence of water with cavitation. The question arises: does electro-hydraulic crushing cause any chemical and structural changes in the coal? Extensive analytical tests revealed that the coal is not subjected to any considerable chemical change in this process, nor is there any significant oxidation.

However, the mineral constituents of the coal do not remain unchanged, since almost all the elements normally found in the ash are found in the filtrate to some extent. Since some of these are of great interest in the chemical and radio industries, their extraction from the filtrate should have a favourable effect on the economics of the process.

In the combustion of coal in gas producers and electric power stations many valuable elements are partly volatilised with the combustion products and partly left in the ash. Experimental electro-hydraulic crushing of coal ash has shown that in this case also nearly all the valuable elements are transferred to some extent to the filtrate. Consequently the electro-hydraulic crushing of ash is of particular interest, not only from the point of view of utilisation of waste products, such as ash from gas producers and power stations, but also from that of increasing the production of valuable elements for the chemical and radio industries.

**L.L.U. Translations Bulletin* (D.S.I.R.), October 1959.

Swedish Heavy Water Process

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This article, which will be published in two parts, contains an exclusive account of the process which has been developed in Sweden for the manufacture of heavy water by the dual-temperature isotope exchange between hydrogen sulphide and water. This first part of the article describes the organisation and scope of the Swedish heavy water programme and gives some details of the first pilot plant and of the technical factors involved.

DURING the past decade, world interest in methods for the large-scale production of heavy water has greatly increased. At present, the market for further installations seems to be unfavourable as the U.S. Atomic Energy Commission is selling heavy water at cost price from installations with considerable excess capacity, but, because of a growing interest in heavy water power reactors, this situation may well change within the next few years.

In Sweden, as in many other countries, it has been considered a necessity to investigate the possibilities of large-scale domestic heavy water production.

Preliminary studies

From the beginning, the Swedish reactor development programme has been based mainly on natural uranium and heavy water. Even if there is no urgent need for nuclear power in Sweden, because of the hydro-electric power available, the heavy water requirement has been estimated to increase gradually to more than 100 tons p.a. within the next 10 years.

It seems possible to produce this heavy water in Sweden as economically as in other countries and the present research and development programme aims to provide sufficient information for a decision to be made as to whether the possible future needs of heavy water should be met by domestic production or not. So far no such decision has been made.

In 1950, preliminary Swedish investigations indicated the possibility of making domestic heavy water considerably cheaper than the then ruling world market price, about £30/lb. This conclusion was the result of a study in which many known or proposed processes had been compared and where the hydrogen sulphide process, known to have been studied in Germany during World War 2, had been shown to have outstanding possibilities. Further studies strengthened this opinion, but the small quantities of heavy water needed by then could be imported from Norway and no real development work was started until 1954.

At that time the Swedish electrotechnical company, A.S.E.A., started a development programme to make production of heavy water possible as a complement to the company's other activities in the nuclear energy field.

It was decided to concentrate the work wholly on the hydrogen sulphide method. A few tons of heavy water a year could have been produced by low-temperature hydrogen distillation or catalytical exchange between hydrogen and water, but such quantities would have been of little interest for a power-reactor programme based on heavy water. If, on the other hand, other reactor systems should prove more economical, heavy water for experimental reactors could just as well be imported.

First pilot plant

A first pilot plant was designed and built immediately and was put into use during the summer of 1955 at the Royal Institute of Technology, Stockholm, where this work was carried out on A.S.E.A.'s behalf. A photograph of this plant appears in Fig. 1. This plant was in operation till the end of 1956 and made it possible to confirm the accuracy of the basic process principles, besides which valuable experience was obtained on the practical problems which accompany the use of corrosive, poisonous and inflammable hydrogen sulphide under pressure.

Effect of American activities on heavy water market

During the progress of this work, the U.S. Atomic Energy Commission at the first Geneva Conference in 1955 announced their ability to sell heavy water in large quantities at £10/lb. This price was declared to represent true cost and at the same time it was revealed that the hydrogen sulphide process used on a large scale had made the American price possible. The A.S.E.A. manufacturing cost estimates had given figures of the same order of magnitude, however, and even if in this new market situation the commercial interest in the project on a short-term basis was gone, its value as a long-term project of great importance for the Swedish nuclear energy programme remained.

Since the beginning of 1958, the A.S.E.A. programme in this field has therefore been carried out in co-operation with, and financed by, the State-controlled A.B. Atomenergi, the first result of this co-operation being a second pilot plant to be described in Part 2 of this article.

Hydrogen sulphide process

The hydrogen sulphide process is based on a hydrogen isotope exchange between water and gaseous hydrogen sulphide at two different temperatures. Owing to the dissociation of hydrogen sulphide in water the hydrogen isotope exchange can be carried out without catalysts.

With a low deuterium concentration in the H_2S/H_2O system most of the deuterium will be present as HDS and HDO, but practically none as D_2S and D_2O, and the equilibrium constant α for the system may be written:

$$\alpha = \frac{HDO \times H_2S}{H_2O \times HDS}$$

This equilibrium constant, which may be regarded as the distribution factor for deuterium between the two phases, decreases with increased temperature according to the following table:

°C.		α
30	..	2.31
100	..	1.96
110	..	1.93
120	..	1.89
130	..	1.86

The enrichment is performed in a

cascade of units each of which is composed of a cold and a hot tower as shown in Fig. 2.

Natural or pre-enriched water is fed to the top of the cold tower and leaves the unit at the bottom of the hot one. Hydrogen sulphide gas is continuously circulated within the unit countercurrent to the water.

In a properly balanced system enriched water can be drawn off from the bottom of the cold tower and this may be looked upon as the result of the cold tower operating as an absorption tower and the hot one as a stripping tower for deuterium. This picture is not quite correct as no free hydrogen or deuterium is involved, but nevertheless it may give a clearer view of the process just as the exchange equilibrium constant may be regarded a distribution coefficient for deuterium.

Process considerations

Deuterium transported by the water from the cold tower to the hot one is partly stripped off from the water and transferred by the gas back to the cold tower where it is absorbed in the water again. The result is a considerably higher content of heavy water in the bottom of the cold tower and in the top of the hot one than in the feed and waste ends of the stage.

To make this possible, the absorption factor should exceed unity in the cold tower and be below unity in the hot one, absorption factor being as usual defined as the product of the liquid/gas ratio and liquid/gas distribution factor for the substance to be absorbed or stripped off.

Disregarding the very small quantity of water drawn off as product, the liquid/gas ratio will be the same in both towers, but the difference in equilibrium constant at the two temperatures will cause the absorption factor to be a little higher in the cold tower than in the hot one. With a careful choice of gas/liquid flow ratio it is well possible to keep the absorption factors of the two towers above and below unity respectively.

This optimum H_2S/H_2O flow ratio is about 4 by weight, which means that very large gas quantities must be circulated and, in practice, a plant will be dominated by the unusually large towers needed.

Maximum yield of the process is dependent on the temperature difference between the two towers, but in any case most of the deuterium content of the feed will leave the unit with the waste water. A material balance will reveal that the minimum fraction of deuterium remaining in the waste water and thus not recovered will be equal to the ratio between the hot and the cold tower equilibrium constants. With the figures given above, a maximum yield of about 20% would be expected, but in practice the equilibrium constants must be corrected for the water vapour content of the gas and the hydrogen sulphide dissolved in the water and the figure will be reduced to about 15%.

Natural fresh water contains about 0.015% of heavy water with very slight local variations, which means that about 20 tons of process feed water will be required for every pound of heavy water produced.

A cold tower temperature of about 30°C. and a hot one between 100 and 140°C. seems to be economically suitable and, to reduce the water vapour content of the hot gas and thereby process heat requirement, the process should be operated at a pressure of 15 to 20 atm.

There is no theoretical limit to the enrichment obtainable in one such unit, but as in most similar cases a tapered cascade will be economically favourable. Regardless of the number of stages used, the first one will be technically and economically dominating, whilst enrichment costs for the final concentration between, for instance, 20 and 99.7% D_2O will amount only to a few per cent. of the total cost.

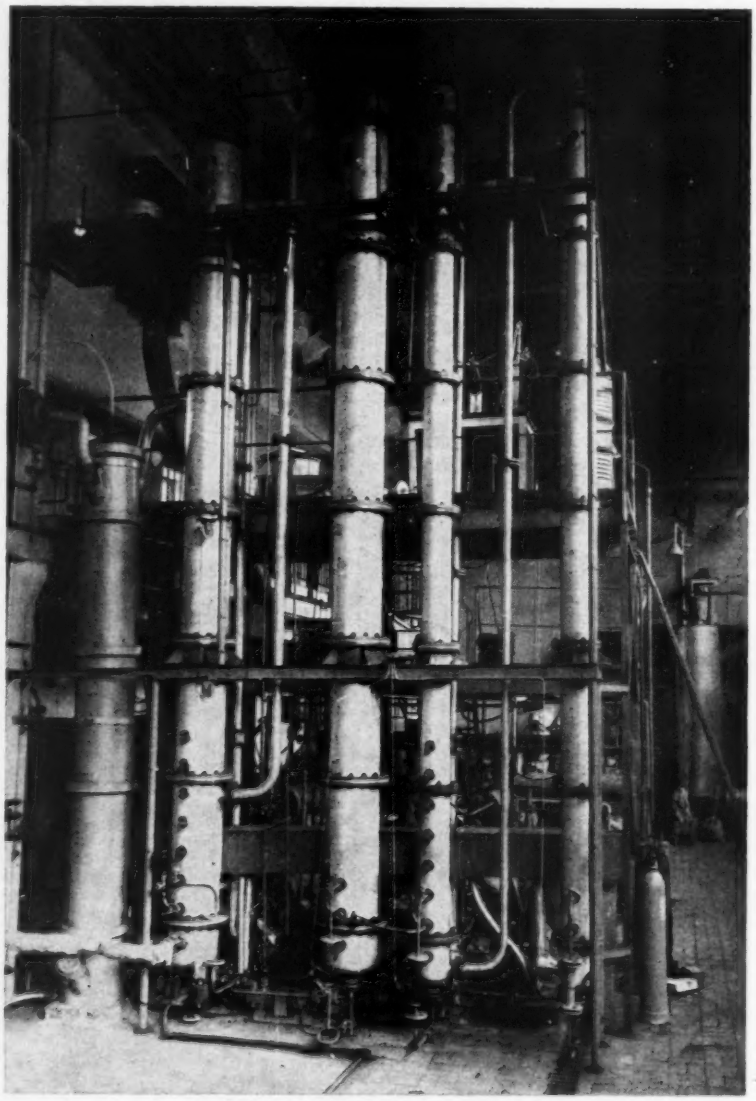


Fig. 1. The first pilot plant.

Safety problems

Production of heavy water is closely associated with atomic reactors and, in fact, there is practically no other market for it, but unlike most chemical processes in the nuclear energy field no radioactive substances are involved.

Hydrogen sulphide, however, is a toxic, inflammable and corrosive substance and, as in this case it is used under high pressure, safety considerations are playing a dominating role from an early design stage onwards.

Although commonly used in chemical laboratories, hydrogen sulphide is just as toxic as hydrogen cyanide. Its characteristic smell of rotten eggs, which is an extremely sensitive indication at low concentration, cannot be relied upon when large amounts are present because the sense of smell is gradually rendered unconscious.

Provisions must be made to protect operating personnel as well as third parties not only during normal operation but also in case of an emergency. To minimise the gas quantity escaping from any major leak, remotely operated shut-off valves should be installed between the different parts of the gas system and a flare stack should be provided to make it possible to get rid of the hydrogen sulphide content of a leaking vessel in a short time.

Materials of construction

Because of the possible consequences of any breakdown, the proper choice of materials is one of the key problems of the process, complicated by the fact that hydrogen sulphide will give rise to serious stress-corrosion cracking as well as ordinary general corrosion, and much attention has been devoted to corrosion research in the Swedish programme.

A rapid general corrosion has been found to occur on mild steel exposed to the process media. The use of this material for certain parts of the plant does not seem quite impossible, however, as iron sulphide formed will protect metal surfaces below, thereby reducing the rate of attack considerably. This protective sulphide layer will be destroyed even at normal fluid velocities, however, and as for the piping system, the advantages of the cheap mild steel are considered to be counterbalanced by the necessity of using larger pipe diameters as compared with stainless-steel piping and, in addition, maintenance costs will be considerably smaller for a stainless-steel system.

Stress-corrosion cracking does not occur on mild steel, but is a serious problem in connection with chromium steel and 18/8 stainless steel. High-grade stainless steel like 18/12/2.5 Mo seems to be resistant, but is too expensive to be attractive and in practice it seems possible to use materials that are not completely resistant, provided proper attention is paid to the mechanical design factors.

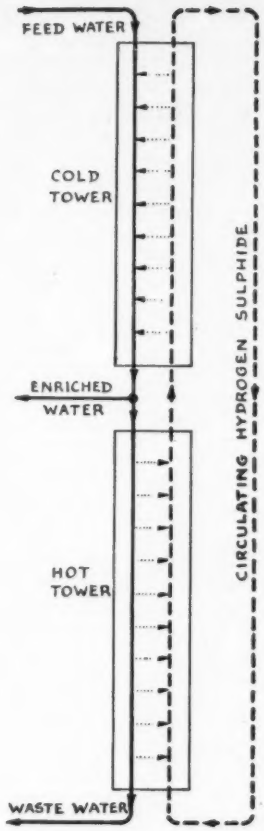


Fig. 2. Enrichment unit.

The hydrogen sulphide stress-corrosion cracking mechanism seems to be entirely different from that of chloride stress corrosion. It has been found that the cracking tendency, which may be very pronounced at 30°C., *i.e.* the cold-tower temperature, decreases very markedly with increased temperature. Atomic hydrogen formed by general corrosion on the metal surfaces and diffusing into the material is believed to play an important role in this special case of stress corrosion.

Part 2 of this article will describe the second pilot plant, which is now in successful operation, and will dwell upon the optimum design of full-scale plant and the economics involved.

Hydrate formation

There is a further factor which adds to the unattractive properties of the hydrogen sulphide. At low temperatures and high pressure a white solid hydrate with the approximate composition $H_2S.6H_2O$ is formed. The operating conditions of the cold tower will be very close to those promoting hydrate formation and a small decrease in temperature or increase in pressure will give rise to clogging of the system. Just as sub-zero temperatures will cause difficulties at plants operating with water, temperatures below 30°C. will be critical in connection with this process, and because of that steam or hot-water tracing will be necessary at part of the process piping.

Tower design

The towers will be large and the choice of tower type will be rather important as tower costs will dominate plant first costs. For the Swedish project, the *Spraypak* expanded metal packing developed by the United Kingdom Atomic Energy Authority at Harwell has been found promising, as it seems to make the towers considerably smaller and cheaper than a bubble-cap design. However, recently released information from the A.E.C. plants indicates that it has been possible to operate bubble-cap towers at considerably higher liquid and gas flow rates than is generally assumed and this may make bubble caps more attractive than *Spraypak*, as so far nobody seems to possess any practical experience of *Spraypak* towers of 10 to 15 ft. diam.

Large quantities of gas and water are to be transferred between the hot and cold zones of the process system and an efficient heat recovery system will be of the utmost importance for the process economy. The system developed for the Swedish project will be described in the second part of this article in connection with the pilot plant where it is now being tested.

To Authors of Technical Articles and Books

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Leonard Hill House, Eden Street, London, N.W.1.

A CPE Chemical Engineering Review

CRYSTALLISATION

Advances in knowledge of crystal growth and structure; crystallisation in the production of urea and other materials; applications in industry, etc.

THIS review follows the general pattern of previous reviews on this subject. The last one appeared in CHEMICAL & PROCESS ENGINEERING, 1957, **38** (8), 324-326, and the present article covers the literature of crystallisation since that time.

Crystal growth

Neuhaus and Meyer[54] have described the basic processes of crystal growth investigated by the use of radioactive indicators. Sheftal and Popov[58] have patented an apparatus for growing mono-crystals. The random motion of the medium in which the crystal grows is brought about by reversible rotation of either the crystal carrier or a stirrer.

Kiriyama[78] has made a general survey, with 13 references, of theories on crystal growth of some artificial minerals from solutions. Kiyama[79] reviewed, with 65 references, methods of synthesis of inorganic single crystals from the melted state whilst Ohara and Masuya[80] studied the growing of single crystals of ammonium dihydrogen phosphate by *p*H control. The crystal forms of potassium chloride, sodium chloride and lithium sulphate have been investigated by Czerwinski, Jaworowicz, Siedlewski and Stundis.[81] For several solutions surface tension and viscosity were determined. There was no evidence of formation of complexes. Some 125 photomicrographs are reproduced. Rittman and El Hinnawi[82] made crystal optical observations on the mixed salts of K_2CrO_4 and K_2SO_4 and concluded that they are completely miscible only at high temperatures.

Kozlovskii[97] described, with diagrams, a set-up for the investigation of microscopic growth of crystals from solution. Anshels[98] has considered the theory of the growth of crystals. A largely new concept of 'physically possible' phases is presented which takes into account the maximum distance at which particles of a crystal can interact with particles of the surrounding liquid or gaseous phase.

Skryabin[20] has discussed the kinetics of crystallisation processes of solutions and melts. Kinetic equations were also derived for the crystallisation with consideration of the thermal resistance of the growing layer of crystals and the thickness of crystalliser wall.

Popov[21] made calculations of the boiling and crystallisation time of sugar concentrates. Different ways of generalising the experimental data on the sucrose crystallisation are reviewed with the object of deriving an equation for calculating the time of crystallisation. Gerasimenko and Golovin[22] describe an apparatus for determination of crystallisation velocity of sucrose. This is done with the aid of a flexible quartz filament in oversaturated solutions at high temperatures.

Albon and Dunning[53] have investigated the growth of a sucrose crystal. Step systems in the form of growth hills are on all phases of sucrose crystals grown at 15 to 30° in either pure sucrose solution, or in the presence of added dextrose or levulose as impurities.

Gordon[28] investigated the growth of crystals of hydroquinone, hexachlorobenzene, quinone and resorcinol, which were studied under conditions of fairly rapid crystallisation and especially under mechanical strain. Applications are discussed of the observations on crystal growth to crystallography and engineering problems. Kovacević[29] reviews methods and some experiences with the crystallisation of mono-crystals from naphthalene-anthracene and sodium iodide (containing 1% T11) melts, giving 23 references. Cartier[30] has investigated the rates of growth for single crystals of anhydrous and monohydrate citric acid. Grillot[31] reported on a new method for the preparation of mono-crystals of cadmium sulphide. Mono-crystals of CdS were prepared by sublimation in atmospheres of H_2, H_2S and N_2. The largest crystals were obtained by sublimation at 1,260°, but at this temperature some dissociation was observed.

Pegoraro[41] has presented a method for calculating the yield of crystals obtained and the amount of solvent evaporated during an adiabatic batch vacuum crystallisation process conducted on a two-component solution (solvent plus solute) which is initially saturated.

Takayanagi[62] determined the molecular weight dependence of rate of crystallisation in polyesters. The process of crystallisation is considered to be determined by the velocity of formation of nuclei and their growth.

Crystals of $Pb(NO_3)_2$ and KH_2PO_4 were studied by Williams,[43] who noted that new growth centres form at points of local deformation. These can be initiated where desired on the face and if strong enough will dominate over the existing centres of growth. This can be done repeatedly, and is suggested as a possible method of controlling flawed regions in artificially grown crystals. Dittmar and Neumann[44] have noted that condensation of potassium vapour on solidified drops of potassium leads to needle-like crystals protruding from the surface of the bulk solid. Such crystals were allowed to continue to grow until their shape and orientation could be determined.

The kinetics of crystallisation of macromolecular substances are described by Kahle.[52] The rate of total crystallisation of *Rilsan* (11-nylon) is followed dilatometrically at temperatures (173 to 84°) above the point of maximum crystallisation. The rate of growth of the spherolites is measured microscopically as a function of temperature.

Dole[4] has investigated the melting range of semi-crystalline polymers and co-polymers. Tanaka *et al.*[7] described a method of making large crystals of ammonium di-hydrogen phosphate by constant-temperature evaporation, and electro-optical behaviour of the crystal. Methods of making the pure

A triple-effect crystallisation plant for producing 150 tons/day of ammonium sulphate, from gypsum liquor, at Stickstoffwerke, Krefeld GmbH., Germany. The equipment was fabricated by Carl Canzler of Duren to the designs and specifications of the Power-Gas Corporation Ltd., who also put the plant into operation.

mother liquor and mother crystal are shown.

Raman[5] presented an approach to specific heat theory that is in a sense rehabilitation of Einstein's original ideas. Koda[33] investigated the relation between crystallisation and the solubility of dihydrostreptomycin sulphate in methanol.

A review of crystal growth has been published by Bennett.[91] This is a comprehensive bibliography of journal articles and unclassified reports, 1951-57, with 545 references.

Crystal structure

Nowacki and Bonsma[83] have considered the crystal and molecular structure of erythraline hydrobromide. Crystal structure of pentaerythritol was refined by Shinod *et al.*[84] with the data of Llewellyn, and with new experimental results. Brandt[85] has considered the theory of molecular chain crystals and its application to high polymers. Most of the properties characteristic of high polymers can be attributed to an interplay of the valence forces between atoms within molecules, and the cohesive forces between molecules. These intra- and inter-molecular forces must be understood separately before quantitative statements about their interaction can be made.

Knacke *et al.*[47] have measured the rate of evaporation of potassium chloride and iodide. The results are discussed in connection with electron-microscope pictures of the crystal surface after evaporation.

Brandoly and Amorós-Portolés[38] have studied a perfect crystal of pyrite with distorted octahedral faces. The (111) faces show a combination of striations which form a stepwise pattern parallel to the lines of intersection with neighbouring planes. At liquid-air temperature, structures due to inhomogeneous formations appear in the crystal faces. The crystal reverts to its original appearance in 48 hr. at room temperature.

The formation of centres of crystallisation in rapidly crystallising liquids can be studied by measuring the time interval in which the first centre appears, according to Mikhnevich.[34] Klug *et al.*[48] have determined the crystal structure of zinc salicylate dehydrate by two-dimensional Fourier methods. Popov and Sheftal[49] have studied mono-crystals which for optical, piezoelectric or other purposes are grown in a seeded crystalliser. When crystallisation is accomplished from a solution and a gaseous phase in the same crystalliser, several crystals are obtained.

Fesenko *et al.*[74] have investigated the properties of single crystals of lead titanate and single crystals of solid solutions (Ba, Tb) TiO_3. Bourre-Maladiere[75] has determined the crystal structure of the monohydrate of sulphuric acid and Dwiggins[76] has determined the crystal structure of potassium trichlorocuprate, $KCuCl_3$. The crystal structure of $M_4S_4H_4$ has been studied by Lund and Svendsen.[77]

Bokii[3] discussed the structural types of chemical compounds including the exact structure of the various classes of molecules, ionic compounds and crystals, while the crystal structure of urea phosphate is described by Sundera-Rao *et al.*[66] Brown *et al.*[16] investigated the crystallography of octa-calcium phosphate. Suito and Ueda[17] have observed the relation between the crystal habit and the lattice image of copper phthalocyanine.

The crystal structure of ammonium hydrogen D-titrate has been determined by Bommel and Bijvoet[61] by a three-dimensional analysis. Prince[14] referred to the crystal and magnetic structure of copper chromite, and Jack and Maitland[15] described the crystal structures and inter-atomic bonding of chromous and chromic fluorides.

Scatturin *et al.*[12] presented data on the crystal structure of silver oxide AgO, and Hardie and Jack[13] investigated the crystal structures of silicon nitride Si_3N_4. The crystal structure of barium tetratitanate, BaO_4TiO_2, has been determined by Lukaszewicz[55] on the basis of rotation and Weissenberg photographs by Patterson and Fourier analysis.

The crystal and molecular structures of acenaphene were refined by Ehrlich[32] with a view to determining the effects of mechanical 'strain' in an aromatic molecule. The results show that bond length remain practically unaltered, so that even the bonds in the naphthalene nucleus are not significantly different from those in naphthalene itself.

Cook and Jaffe[25] have given crystallographic descriptions of K and NH_4 pentaborate, including a review of previous conflicting data. A dislocation theory of fracture of crystals has been discussed by Fujiyata.[90]

Joel and Wooster[9] have presented theories on crystal elasticity. The classical theory of crystal elasticity assumed that the equilibrium of a tube within a body at rest, which is subjected to any given set of mechanical stresses, is maintained solely by the forces acting normally or tangentially to its surface. The new theory asserts that 'volume-couples' can also exist, and that these must be balanced by the difference between the couples, which were assumed to be equal and opposite in the old theory.

Tang and Kuei[99] have examined the crystal structure of anhydrous sodium

sulphite, whilst that of anhydrous magnesium sulphate has been investigated by Rentzeperis and Soldatos.[100] The preparation of thin single crystals of barium titanate are described by J. T. Last.[50] Crystal thickness during etching was observed with a low-power microscope.

Eckstein[72] presented a review, with 50 references, of the problems of imperfections in crystals. A review of dislocation in crystals, with 111 references, was presented by Indenbom.[62]

Urea

Chemical Construction Corporation have described a process for the manufacture of synthetic urea from carbon dioxide and liquid ammonia.[60] The product is urea in any of the following forms: urea solutions, spherical granules (prills) for fertiliser, cattle feed supplement and crystals of high purity for plastics manufacture. Liquid ammonia and liquid carbon dioxide, free of sulphur and oxygen, are fed into the synthesis autoclave in the ratio of approximately 6 moles of ammonia to 1 mole of carbon dioxide. In the autoclave, 1 mole of carbon dioxide reacts with 2 moles of ammonia to form ammonium carbamate which, in turn, partially dehydrates to form urea. The reaction is shown by the equation:

$$CO_2 + 2NH_3 \rightarrow \underset{\text{Ammonium carbamate}}{NH_2CONH_3OH} \rightarrow \underset{\text{Urea}}{NH_2CONH_2} + H_2O$$

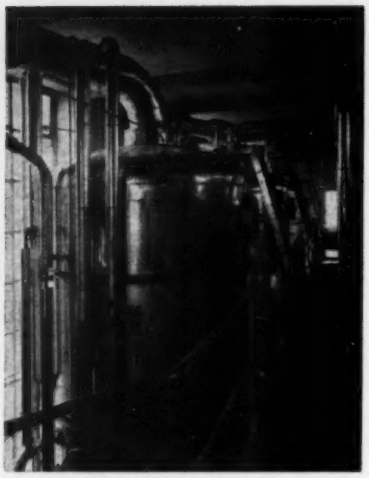
Control of biuret content of the prilled product is claimed possible by recent improvements in the Montecatini process.[51] Montecatini claims that its process can now evaporate urea solutions to less than 0.8% before prilling so that subsequent drying of prills is unnecessary—and do it while keeping critical biuret content below 1%.

A multi-stage process for concentrating solutions of urea to give solid of low moisture—and biuret—content is recorded in a Stamicarbon M.V. Belgian patent report.[27] Concentration is effected *in vacuo*, the final stage being effected by leading an 87 to 96% solution into a reactor and expanding the solution therein to a pressure below 100 mm. Hg; the water vapour produced is withdrawn quickly and the inflow of heat is adjusted to maintain the temperature of the residue below 145°C.

Again on the subject of urea, a recent article[36] records a process for the separation of straight-chain components from a mixture of hydrocarbons. Examples: isomer fractionation, dewaxing of lubricating oils and jet fuels, and the preparation of *n*-paraffin fractions. The products include:

(*a*) The straight-chain extract.

(*b*) The raffinate—that portion of the feed which did not form a crystalline complex with urea.



A view of the upper part of the Krefeld crystallisation plant illustrated on the previous page.

Stamicarbon have reported their observations on the production of granular urea.[18] In this, 0.01 to 0.2% (by weight of the urea) of an anion-active foaming agent such as *Santomerse* or *T-Pol* is added to the concentrated solution of urea. A slowly flowing, thickly foaming mass is thus formed from which dry, coarse crystals (moisture content 0.2%) are obtained.

Monsanto Chemical Co. have patented[19] an entirely new continuous process for making ureas by reacting carbon monoxide, sulphur and ammonia or an amine, with the reaction preferably carried out in the presence of a solvent such as methanol. The reactants may be fed into the base of a packed column together with carbon monoxide. Product urea in solution is removed from the top of the column and separated. The solvent is recovered for re-use and hydrogen sulphide and excess ammonia recovered in the form of ammonium sulphate and elemental sulphur. While the concurrent reaction of ammonia, sulphur and carbon monoxide in a packed column (as disclosed in the co-pending application of Applegarth *et al.*, serial No. 437,882) produces good product yields of urea economically as compared with the conventional prior art processes involving the reaction of ammonia and carbon dioxide under high pressure and temperature, it is found that this new urea process can be still further improved from the standpoint of operational steps so that it can be better adapted to continuous commercial operations.

Báthory[57] has outlined the operational principles for the design of a continuous plant for extractive crystallisation with aqueous urea solutions in the presence of acetone.

Crystal purity

Struthers Wells Corporation, U.S.A., have filed a patent application[10] directed to a process for the manufacture of phosphoric acid from phosphate rock and like sources of phosphorus by the so-called wet process. It is directed more particularly to controlling the addition of inorganic acids to the reaction mixture to facilitate separation of calcium salt crystals such as calcium sulphate from that mixture.

Svanoe has written a paper[11] in which he observes that an outstanding characteristic of the crystallisation process is that, in many cases, it is the only way to obtain high-purity materials from impure solutions. Crystalline chemicals are produced under widely different operating conditions. The product may have to be crystallised at a temperature of several hundred degrees Centigrade, or well below zero. At operating conditions, the viscosity of the solution may be equivalent to water, or several thousand times greater. This means that the designer of crystalliser equipment must be prepared to evaluate the relative importance of the chemical and physical characteristics to obtain the objective at the lowest cost. Some of the factors considered in the design of equipment to produce crystalline material from solutions are discussed in this paper.

Vadilo[69] discussed the problems involved in the crystallisation of substances (KCl) without the inclusion of impurities.

Trnka[8] investigated copper as an activator in sodium chloride crystals. The valence of copper present in NaCl crystal as an impurity was determined polarographically.

A systematic experimental study on the crystallisation of borax by Garrett and Rosenbaum[101] presents results sufficiently defined to serve as a reference for pilot-plant tests and future plant design. In many industrial crystallisation processes closely sized and specifically shaped crystals of high purity are required. With well-

designed equipment and proper process control, the desired product may usually be obtained. However, establishing the optimum conditions and design with a different system may require a detailed study of the variables, especially for the most effective and economical enlargement of an existing plant's capacity. This laboratory study of borax crystallisation was undertaken for this reason.

Sodium chloride

Bain and Rumford have studied the controlled crystallisation of sodium chloride in a *Krystal* pilot plant.[24] The rate of growth of sodium chloride crystals in a fluidised bed was determined over a temperature range of 26 to 73°C. The effects of fluid velocity and a surface-active agent were investigated and the results suggest that crystallisation is diffusion-controlled below 50°C. The authors observed that crystal quality tends to become poor above a rate of deposition of 0.07 g./sq.cm. of crystal surface per hour. The 'metastable limit' of supersaturation for sodium chloride crystallisation under evaporation conditions was determined. At any higher figure nucleation rates rapidly increase. On the basis of their experimental work the authors make suggestions regarding the design of industrial plant.

Application and industrial practice

McKay[59] has patented an apparatus which describes crystal purification and separation from multi-component mixtures which form eutectics. The eutectic composition is first passed into a purification zone where mother liquor is removed, then into a melting zone. The temperature in this section is intermediate between the eutectic temperature and the crystal melting point, resulting in partial melting. Occluded impurities are released and washed out.

Frejacques[46] patented a process for avoiding film-type overheating of the solution containing medium-sized crystals passing from the crystalliser to the evaporator and simultaneously providing enough heat to dissolve fine crystals.

An apparatus for low-temperature crystallisation was described by Kajanne.[87] This apparatus can be immersed in a Dewar flask wherein filtrations can be carried out at low temperature with minimum thermal disturbances, and atmospheric moisture does not gain access to the solution. Green and Clark[88] have patented a continuously circulating crystallisation process. Purification and separation of organic compounds by crystallisation is improved by introducing a solution of the compounds into a crystal slurry circulating rapidly past a cooling surface. Chilton[89] has described a key step in sodium sulphate crystallisation process. The production of Na_2SO_4 from Searles Lake brine is illustrated with the aid of a pictured flowsheet.

An improved process for the separation and purification of liquid multicomponent mixtures has been patented by Phillips Petroleum Co.[42]

The economic aspects of scaling up chemical plants are reviewed by Dickerson.[35] The economics of increased dimensions are reviewed and capital and production costs are estimated for a plant with outputs of 500, 3,500 and 14,000 tons p.a.

Stainless-steel ammonium sulphate crystallising tanks can be prevented from corroding by certain of about 15 substances studied by Roberti *et al.*[56] as inhibitors, in particular by adding $CuSO_4$, $K_2Cr_2O_7$, H_2O_2 or $NaAsO_2$. Ratje[2] has patented an apparatus to be used, for example, to obtain high-purity *p*-xylene by crystallisation from a mixture of isomeric C_8 alkylbenzenes. Cook[1] has described the improvements for more uniform boiling and flow pattern and efficient disengagement of vapour within the available space, resulting in reduction of aggregate formation.

Experiments on a batch vacuum crystalliser with a mechanical agitator were carried out by Nakajima and Oshima[23] to determine the evacuation rate of the apparatus by the rotary vacuum pump and the cooling rate of the liquid previously fed to the insulated vessel. The liquids tested were water and two kinds of aqueous solutions ($Na_2CO_3.10H_2O$ and $Na_2SO_4.10H_2O$). Experimental relations are presented to calculate the time required to reduce the pressure in the vessel and to cool the solution respectively.

Ladd[92] has patented an apparatus for the preservation of surfaces of soluble salt crystals, and Green[93] has patented a method for the preparation of a partially solidified feed slurry for charging to the separation apparatus. Yoshida[94] describes a continuous vertical crystalliser which comprises a tower equipped with a helical screw through its axis. Crystal nuclei are lifted by the screw. The crystal nuclei grow while in contact with the solution which is supplied from the bottom of the tower and passes upward through many holes drilled in the screw wings. Crystals are collected at the top. Weiss[95] patented an apparatus for growing crystals. This method is particularly suited to the growing of semiconductors and in which the seed may be rotated and vibrated while being grown by withdrawal. Nutrients are added through a heated cavity so that growth is not disturbed. A patent by Findlay[96] is for a method of crystal purification in which the separation of liquid materials in a plurality of steps is described.

Experiments in the preparation of crystalliser seed slurry were carried out by Nakamura.[71] These experiments for boiling refined sugars were made on sugar solutions prepared at 110 to 20°. The slurry obtained by this experiment was kept in good condition for 24 hr. when the container was covered with a wet cloth.

Vela[73] has patented an apparatus for the purification of crystals. Two purification columns joined at their melting sections provide a means of obtaining continuous feed and withdrawal, counter-current liquor-crystal flow, and high fractional purification.

Ruthner[68] has patented an apparatus for removing the solutes from solution by crystallisation, comprising a cyclone for effecting crystallisation and a separator for separating the crystals from the liquor. The object is to improve the yield and prevent the crystals from caking on the walls of the cyclone. It is claimed that this improvement is achieved by making the lower part of the wall of the cyclone—preferably extending over more than half the height—of a yielding material such as rubber.

A patent application filed by Struthers Wells Corporation[6] relates to the manufacture of soda ash from caustic liquors, and more particularly to the production of sodium carbonate monohydrate crystals, using caustic liquor obtained from electrolytic chlorine cells. The method makes use of an improved carbonation process which employs the *Krystal* crystalliser.

Miscellaneous investigations

Park[64] gives a method for summing the high- and low-temperature expansions that derive from calculations of crystal statistics. Barrer[65] has given a lecture, with 47 references, on 'Some Properties of Water in Crystals.'

Golovin *et al.*[86] have determined the rate of crystallisation of sucrose in green molasses at the temperatures of 70°, 80° and 90°. In solutions with the same coefficient of supersaturation

the rate of crystallisation of sucrose increases only with the rise of temperature up to 80°. With further increase of temperature the rate of crystallisation decreases.

Sugawara and Kimura[67] have patented a method for the purification of ammonium sulphate mother liquor with recovery of selenium.

In a crystallising system of one or more well mixed vessels, the crystal size distribution is described by a simple function whose only variable is the mean retention time, according to Robinson and Roberts.[37] As the number of agitators in the system is increased, the size distribution of the crystals becomes more uniform, but the mean size decreases for a given rate of production per unit volume.

The suitability for adsorption of dyes of the principle low-index planes of potassium nitrate is discussed by Whetstone[26] in the light of the scheme proposed previously by the author to explain crystal habits in dyes.

Sheftal[45] has reviewed critically, with 44 references, factors affecting the crystallisation process (degrees of association, presence of admixtures, crystallisation pressure) and the mechanism of crystallisation under conditions of equilibrium, forms, and the solubility of crystals. Numerous photographs of various crystals during different stages of formation are shown, as well as diagrams.

Zhvirblyanskii *et al.*[39] have reported an experiment on obtaining crystalline sugar without boiling the liquors in a micro-laboratory setting. This is a method of crystallisation from oversaturated solutions by cooling in the presence of introduced crystal nuclei as seeds, while Zelikman[40] has examined the influence of excessive supersaturation of sugar solutions and speed of crystallisation.

Peironet, Fouche and Martineau[70] have described a procedure for the preparation of single crystals of cadmium sulphide. Single crystals of CdS are grown from an amorphous precipitate of CdS in a closed vessel at ordinary pressure in neutral atmosphere under a carefully controlled temperature gradient.

Acknowledgment

The foregoing review is contributed by the *Krystal* department of the Chemical Plant Division of P.G. Engineering Ltd. (a member of the Power-Gas Group) to which company thanks are due for permission to publish it.

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NUCLEAR NOTES

Co-operation in Europe

Representatives of the nuclear associations of the six European Community countries met in Rome in December under the chairmanship of Prof. A. M. Angelini, Italian Nuclear Energy Forum President.

During the meeting at the Nuclear Research National Committee organisational problems were examined for a closer co-operation between the six countries' associations, counting among their members organisations, industries, and people interested in nuclear problems. A joint action programme which was drawn up for study may be implemented with the participation of other countries.

It was decided to hold a further general meeting in May 1960 in the Netherlands, and that the work group will meet in Brussels.

Borated graphite at Dounreay

For the first time, special borated graphite blocks were used by the U.K.A.E.A. in the assembly of the shield which surrounds the vessel for the fast breeder reactor at Dounreay, started up recently. The blocks were made and machined by the Morgan Crucible Co. Ltd.

The purpose of the borated graphite is to slow down fast neutrons and then absorb them in the shortest possible distance, thus providing a safety screen. Most of the graphite contained 0.3% boron, but some contained 5%—in both cases very uniformly distributed. The blocks were machined to 500 different patterns, some of which were so intricate that wooden dummies had first to be made to ensure that it was practicable to machine them in graphite. As a final check, the layers of finished graphite blocks were assembled at Morgan Crucible's Norton works into their complicated form of eccentric circles.

Non-toxic nuclear battery

A recently developed, non-toxic nuclear battery sheathed in corrosion-resistant stainless steel is expected to deliver useful power for over 10 years without failure. Radiation Research Corp., U.S.A., originally designed the 1-oz. battery to operate timing devices but believe it is suitable for many similar designs where long-life power delivery is needed under difficult working conditions. The atomic power pack contains Krypton-85 gas pressurised at over 140 lb. Unlike some other radioisotopes, the gas is not absorbed by the human body, thus adding a safety factor to the unit.

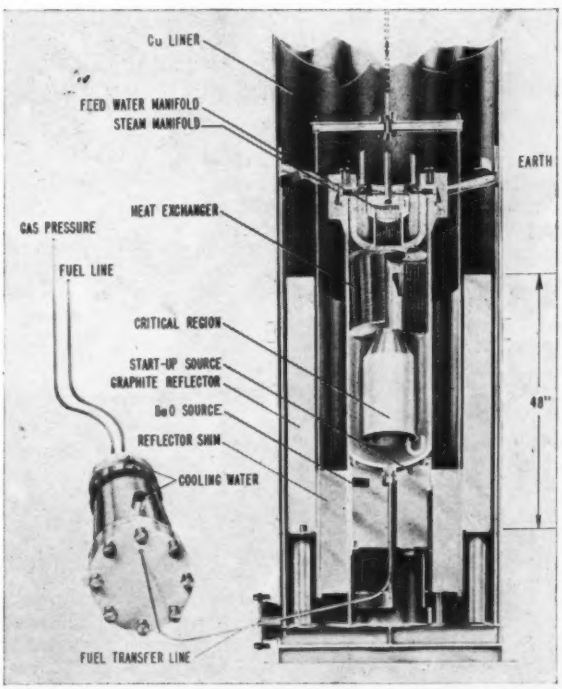
In operation, the Krypton-85 gas emits β particles which penetrate a solid dielectric substance. Each cell develops about 5 kv. on open circuit, with a no-load current of 100 micro-microamp. The battery produces power at temperatures between −175° and +165°F.

Homogeneous reactor at Los Alamos

A homogeneous power reactor experiment designed to produce superheated steam was recently being tested in the U.S.A.E.C.'s Los Alamos Laboratory, operated by the University of California. The purpose of the Los Alamos Power Reactor Experiment No. 2, *Lapre II*, is to determine the feasibility of a reactor concept using a solution of enriched uranium phosphate, phosphoric acid, and water as fuel, relying on natural circulation of the solution to carry the heat to the heat exchanger where steam is produced. The reactor is designed to produce high-pressure superheated steam suitable for modern electrical turbines and is expected to generate 1,000 kw. of heat.

Operational tests will study the steam generation, response of the reactor to power demand, corrosion control by gold cladding of internal components, and radiation stability. The first reactor under the homogeneous reactor programme at Los Alamos, *Lapre I*, was dismantled in 1957 because of excessive corrosion in the heat exchanger. It used the same fuel solution but relied on a circulating pump to carry the heat to the exchanger.

The heat exchanger is enclosed in the same pressure vessel as the fluid but, because the latter is extremely corrosive, gold cladding protects the structural metals in contact with the solution. The cylindrical gold-lined stainless-steel pressure vessel is 4 ft. tall and has an inside diameter of 15 in.



An artist's drawing of the design features of the 'Lapre II' reactor.

Criticality is achieved by inserting the liquid fuel in the reactor core. As the fuel temperature rises from 70° to 800°F. because of the nuclear reaction, the fuel expands 15%. This expansion reduces reactivity until a stable temperature is achieved. When cold water is passed through the heat exchanger coils, heat is withdrawn from the fuel, the solution contracts, increasing reactivity and automatically compensating for the heat loss. The fuel temperature remains essentially the same whether or not heat is being withdrawn from the system.

Impulse Rendering

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Of the various sub-divisions of 'biochemical engineering,' one of the most important industrially is in the field of extractive biochemistry, involving the extraction and recovery of natural products, such as fats, carbohydrates and proteins. The following article describes a recent chemical engineering operation that has revolutionised the industry by providing a novel means for cellular rupture.

THE problem of extracting substances from biological materials is two-fold. In the first place, both plants and animals are made up of cells of microscopic dimensions which possess fairly resilient cell walls that have to be broken or denatured in order to release the required contents. Secondly, the living cell contains degrading as well as synthesising enzymes. In the intact cell, the degrading or lytic enzymes are safely retained in sites out of reach of the required substrate, but as soon as the cellular organisation is disintegrated, these enzymes are released and are likely to break down the natural products wanted.

To extract natural products, therefore, the substance must first be released from the cell and then protected from enzymic attack. This latter condition may be fulfilled either by speedy isolation or by inactivating the enzymes.

It goes without saying that the means for release of a compound from the cell must not be such as to affect that substance adversely by physical or chemical damage. In this respect, many natural products are heat-labile, and are degraded by the application of heat. Thus, for example, in the extraction of fats, the common industrial methods are heat rendering and hot solvent extraction; but in both of these methods, the product is damaged sufficiently to necessitate further purification to remove colour and odour.

It has now been recognised that mechanical extraction in the cold would be the ideal means for handling natural materials, provided that the product could be isolated quickly.

The search for a mechanical method suitable for commercial exploitation was ended in 1952 when the impulse rendering process (the Chayen process) was announced by British Glues & Chemicals Ltd. This technique depends on the generation of impulses, or shock waves, in a suitable fluid, and these break open the cell wall by a means that has been likened to the effect of depth charges on a submarine. In general, the fluid through which the impulses are transmitted is water, but other liquids could be used, and a modification of the principle for other purposes has even used air as the transmitting medium.

Description of machine

The impulse renderer in its most elementary form is simply a hammer mill that has been modified by reducing the length of the hammers so as to allow a clearance between the hammer tip and the screen. The raw material to be extracted is fed into the machine, together with a stream of water, and the shock waves caused by the high-speed beating of the rotating hammers in the water have sufficient energy to rupture the cell walls and thereby release the contents of the cells.

Although it is convenient to use a hammer mill for this purpose, it must be obvious that the mode of action is different, as the high-speed grinding action of the mill would become very inefficient on allowing a large clearance between hammers and screen, whilst the introduction of water, too, would be expected to hinder efficient grinding. Admittedly, particle size reduction of solid material, such as bone, does occur in the impulse renderer, since the material is hurled with considerable momentum against the walls of the machine; but whereas the particle size of the solid after processing may be measured in fractions of an inch, the size of the animal or vegetable cell is measured in microns. It is therefore apparent that the normal action of the hammer mill is incidental to the process, and that the rupturing of the cell is due to the impulses transmitted through the fluid medium. One particular advantage of impulse rendering is that the action is almost instantaneous, lending itself to a continuous process.

The technique of impulse rendering will now be discussed in greater detail, taking first as an example the removal of fat from bone, a process that has been operated successfully for the last nine years, and which was the first process to exploit the new fat-rendering operation.

CONTINUOUS COLD DEGREASING OF BONE

Bones provide one of the two principal raw materials for the glue and gelatine industry. Glue and gelatine are both obtained by controlled hydrolysis of the collagen that is present in bones, but which is always associated with fat and contaminated by impurities such as blood. The bones must therefore be cleaned, and the fat extracted, if the hydrolysed collagen is to be free from contaminants. The classical method for degreasing bones relied on heat rendering or on solvent extraction, but both these methods affect the collagen adversely; also, in dry rendering, as much as 6% fat remains in the bones. The impulse-rendering technique is advantageous for a number of reasons, including the following:

(*a*) The fat is extracted in the cold, so the quality of neither the collagen nor the fat is affected.
(*b*) The extraction is efficient, the degreased bones containing no more than 2% fat.
(*c*) Passage of bone through the impulse renderer takes less than a second, so the degreasing can be carried out as a continuous process.

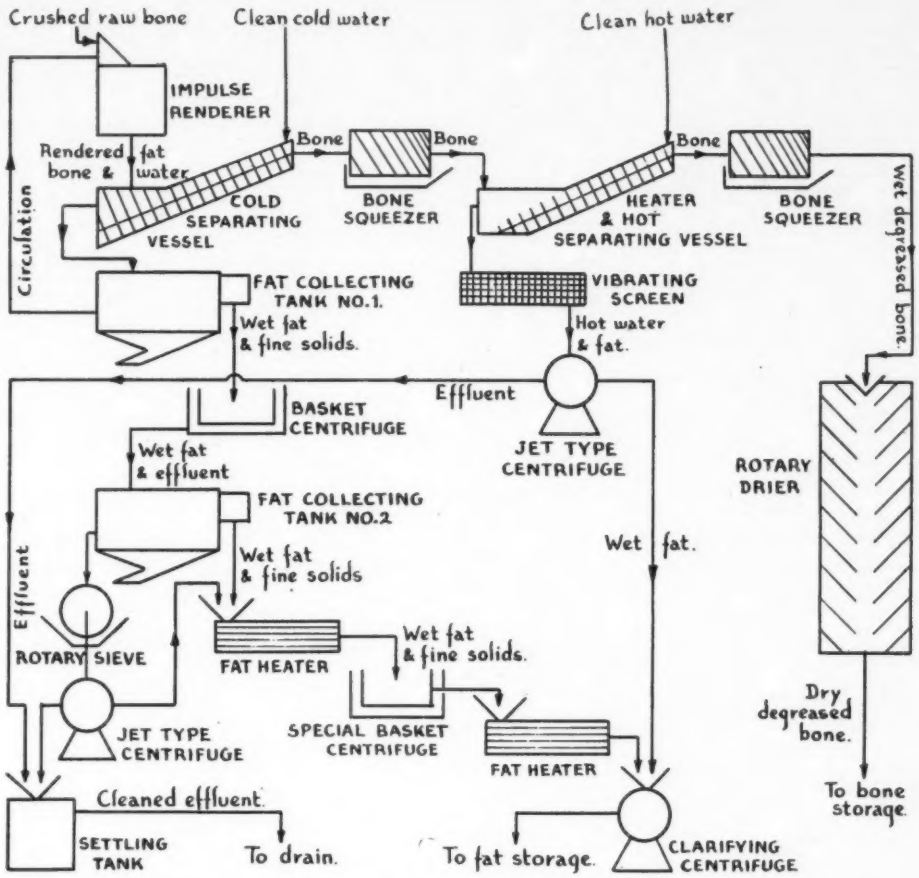

Fig. 1. Flow sheet for impulse rendering process as applied to the continuous cold degreasing of bone.

Process variables

As has already been stated, the impulse renderer in its simplest form is just a modified hammer mill. The variables involved in the impulse rendering process have been listed[1] as follows:

(i) Speed of rotation of beaters.
(ii) Shape, form, weight and distribution of beaters.
(iii) Grid size and arrangement.
(iv) Nature of liquid.
(v) Amount of liquid.
(vi) Temperature of liquid.
(vii) Size of material submitted to process.

Factors (i) and (ii) govern the force of the impulses, whilst the grid size affects the time of retention in the impulse renderer. So, for example, when the cell walls of the raw material are easily ruptured, only a short time of retention is required, and the grid size can be made larger than usual. For tougher materials, in additon to increasing the retention time, the speed of rotation and the weight of the beaters may be increased, thereby imparting a greater force to the impulses produced.

Details of equipment

The original design of the impulse renderer has been modified in many respects for the different raw materials encountered, and many details of such modifications are described in a recent patent specification.[2] A fairly typical model employs 54 hammers, made up of six rows of nine hammers; these beaters are 1 in. thick, 2 in. wide and 6 in. long, providing a clearance of 1 in. between the ends of the hammers and the screen. In dealing with bone, the slots between the bars of the screen were $\frac{1}{4}$ in. In other modifications, knife blades are incorporated to cut up sinewy material; a single, large relief opening is then left at the discharge end of the impulse renderer to allow the escape of any sinew that is too large to discharge through the screen.

Performance

In the form described the impulse renderer can deal with a throughput of 4,700 lb./hr. of raw bone. The bone is crushed to a size of 1 to 2 in. and is fed into the impulse renderer with about five times its weight of water. The actual volume of water used is not highly critical, but it is found in practice that the liquid cannot be reduced below three times the weight of material to be rendered, whilst the use of too much water is merely wasteful. The power requirements are found to be fairly constant over a wide range of feed rates, but when too little water is present the power increases rapidly because of

increased resistance to the rotation of the beaters; this characteristic can be used in the automatic control of the feed rate.

The generation of the shock waves requires somewhat less than 100 h.p., imparting a speed of 2,500 r.p.m. to the rotor, which results in a peripheral speed of the hammer tips of about 15,000 ft./min.

Statistics have been given[3] for a bone-rendering plant operating at 1,800 impulses/sec. and a tip speed of 13,000 ft./min. It was stated that the power requirements for a 5,000-lb. unit were 150 kwh. as against 75 kwh. for a comparable dry rendering plant, but the fuel consumption was only one-third as much and the plant could be operated by two men.

Fat extraction and processing

After the bone has been rendered—a process which takes less than a second—the degreased bone, cold-rendered fat and effluent pass through the screen into a bone-separating vessel. The bone settles under gravity and is continuously removed by a scroll conveyor on which it is washed with cold water. The cold-washed bone is passed through a squeezer and then washed with hot water in another separating vessel. This hot-water wash takes place at a temperature of 90°C., but the mean time of the bone in the vessel is only about 2 min., so that degradation of collagen is minimal. The treatment has the effect of removing surface-held fat and of shrivelling the swollen sinew in the bone. The wet, degreased bone passes through another squeezer to reduce the moisture content to 36%, and is then dried on a rotary drier, or else passed directly on to a glue-extraction process.

The fat, on emerging from the impulse renderer, floats to the top of the bone-separating vessel and passes into a fat-collection tank. Here again it settles at the top, and it is floated off into a basket centrifuge which removes the bulk of the suspended fine solids, and at the same time thickens the fat. The thickened fat undergoes a further passage through another fat-collection tank, and is removed from that vessel continuously into a fat heater in which the fat is melted at a temperature of 60°C. The liquid fat passes through a special basket centrifuge to remove the small amount of fine solids remaining, and the operation also separates the fat from water. The separated fat is finally passed through a line heater, where it is heated to 85°C., then through a clarifying centrifuge and into a storage tank.

It should be noted that, from the start of the process, the fat is not subjected to a heat treatment until free from fat-degrading substances. Also, the total time of the process from rendering of the bone to the recovery of polished fat is less than 5 min., so that the possibility of the fat being degraded is extremely unlikely. A typical analysis for the finished tallow produced by this process shows less than 0.02% moisture and impurity, a free fatty acid content of 1.5%, and a titre of 41.5°C. It is considered that these characteristics are directly dependent on the quality of the raw material and that no degradation of the fat occurs in processing.

In this brief description of the impulse rendering process as applied to bones, no mention has been made of the more detailed stages of further fat recovery from secondary operations, nor has the treatment of effluent been described. More comprehensive accounts of the process have been given elsewhere.[1, 4] However, a flow sheet for the process is shown in Fig. 1.

Characteristics of products

Tallow is extracted in 98% yield (with properties as mentioned above) as compared with less than 95% in heat-rendering processes and 99% in solvent extraction. The fat is of high purity, is sweet-smelling, has good colour, and possesses excellent keeping qualities. The bone material prepared by the impulse-rendering method contains only about 2% fat, and 35% protein as compared with 28% in the original heat-rendering process used. As a result, the yield of glue is increased by 25%. Because the collagen is not degraded by heat, the glue has a higher viscosity and three times the gel strength of that produced by the previous process.

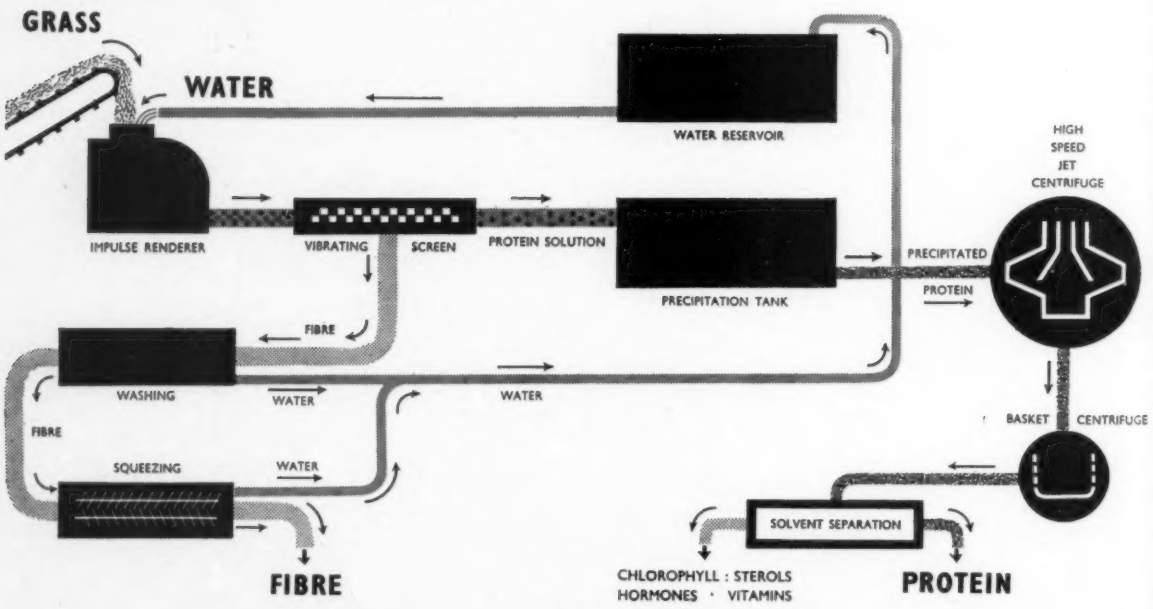

Fig. 2. Simplified flow chart for industrial impulse rendering of vegetable material.

OTHER APPLICATIONS

Development work on the impulse-rendering technique has shown it to be applicable to a wide range of extraction processes. Thus, fish-liver oils can be obtained in 98% yield, with a vitamin content probably up to 20% higher than that obtained from conventional processes. In the general extraction of oil from fish, too, the impulse treatment appears to be superior to previous methods in two respects:

(*a*) A lighter-coloured oil is obtained, with a lower content of free fatty acids.

(*b*) The fish meal is reduced to a low oil content, of 4%, thereby rendering it more acceptable as a protein-rich feeding stuff.

Recovery of protein

After overcoming initial difficulties, it has now proved possible to impulse-render vegetable fruits, such as olives and palm fruit, and also to extract vegetable seeds. Arising out of this work it was appreciated that the rupture of the cells for extraction of oil had made available all the other cell constituents, of which the protein would be extremely valuable if it could be recovered. In fact, on consideration of the vast quantity of vegetable material processed for its oil content, it must be obvious that, should the protein be extractable, the quantity available would help in no small way to solve the protein deficiency of the diet in underdeveloped countries.

Fortunately, vegetable protein is soluble in dilute alkali, though insoluble in acidic medium. This principle has been utilised by British Glues & Chemicals Ltd. in the process they announced last September for the extraction of protein from both leaf material and oilseed. Their product is referred to as *Impulse Process Protein*, and the extraction is therefore known as the IPP process. Inasmuch as the process has now been applied to the extraction of high-nutritive value protein from grass, the impulse-renderer as used for this extraction has become known in the popular press as the 'mechanical cow.'

'IPP' process

The basis of the IPP process is impulse rendering of the vegetable material with water made slightly alkaline by the addition of caustic soda. The fibre remains insoluble, and can be separated from the soluble cell constituents including the protein. This is the simple case, as encountered with leaf material, but with oilseeds the separation has to take account of the free oil released at this stage. The oil, fibre and solution are then separated by the use of a high-speed jet centrifuge.

The clear alkaline solution is passed into precipitation tanks, where sulphuric acid is added until a *p*H of 4.5 is attained. This precipitates the protein, which is then allowed to settle so as to effect a preliminary separation from the supernatant liquid. The protein sludge is passed through a basket centrifuge to concentrate it further, and the thick paste obtained is transferred to a solvent extraction plant. Here the water is removed by azeotropic distillation, and the solvent also splits off protein-bound lipids. In this way, apart from drying the protein to a fine powder, a valuable oil is recovered, containing sterols, hormones, fat-soluble vitamins and, in the processing of leaf material, chlorophyll and carotene as well.

Although the process is designed for the commercial production of protein, with the simultaneous production of oil in the case of oilseeds, the attractive economic feature is the value of the by-products. Thus, the extracted fibre may be used for making hardboard, whilst the lipid fraction removed from the precipitated protein is a treasure store of fine chemicals. The protein, though still slightly off-white in the grass product, is a pure white when extracted from many oilseeds, and is virtually tasteless. Feeding tests on animals have shown it to possess excellent nutritive value, and human feeding tests are now in progress. A schematic flow sheet is shown in Fig. 2 to illustrate the nature of the process for leaf materials; a slight modification is made for oil-bearing raw materials.

FUTURE PROSPECTS

In processing proteinaceous materials that also contain free oil, it has frequently been observed that a lipid-protein complex is recovered that does not correspond in composition to anything present in the original material. The complex can be redissolved and reprecipitated continually without changing the composition, and appears to have the properties of a true lipoprotein. This gives rise to the obvious notion that the linkage was formed artifically by virtue of the impulse-rendering treatment, and one might further speculate that herein lies a method for the more general production of artificial complexes, and perhaps even of copolymers. It may even be possible that the energy generated to form these associations may be utilised to carry out reactions that are feasible from thermodynamic considerations, but which require a means for overcoming the energy barrier (energy of activation).

Regardless of such attractive speculations concerning the use of the impulse renderer as a general reaction vessel, some of the success of the machine is undoubtedly due to its high-speed stirring effect, by which compounds released from enclosure within the cell wall are rapidly brought into solution. This efficient means of effecting solution will almost certainly be an important means of extracting soluble substances from a wide variety of raw materials, even when cellular rupture is not a feature of the extraction.

Chemical applications

In conclusion, it seems probable that impulse rendering will find increasing application in the chemical industry, especially in the field of extractive biochemistry, not only to replace existing methods but to make available new processes that were not possible previously for want of a suitable technique. Now that the second process involving impulse treatment has proved successful, a great deal of interest has been aroused in those industries that are involved with biochemical engineering, and a wide utilisation of the principle can be expected in the future.

Acknowledgments

I wish to express my thanks to British Glues & Chemicals Ltd. for permission to reproduce the flow sheets and other data; and also to Mr. I. H. Chayen for help with the preparation of this article.

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Plastics and rubbers. A data book describing their range of PVC materials and *Hycar* nitrile rubbers and latices has been published by British Geon Ltd., Devonshire House, Piccadilly, London, W.1. It provides basic technical information and is divided into four sections, each dealing with a separate group of materials.

FROM PELLETS TO PALLETS

A Special 'CPE' Survey of Materials Handling Advances

★ *The application of the principle of handling goods and materials in 'unit loads' and the integration of materials-handling machinery in complete, automatically controlled flowlines have been the dominant trends in this field over the past few years. Along with wider recognition of the need for careful planning of materials handling for maximum speed and efficiency there have been a number of developments in equipment for handling, storing and transporting raw materials, intermediate products and finished goods, and some of these are briefly reviewed below.* ★

Pastillation of chemical products

The problem of solidifying molten chemicals into pellets or pastilles without the formation of dust can be solved by the use of a continuous, automatic process embodied in the Kaiser-Rosin *Pastillator*. This can deal with a variety of products ranging from organic chemicals such as maleic anhydride, rubber chemicals, artificial resins, waxes, low-molecular polythene and glues, to high-melting inorganic chemicals such as the hydroxides and cyanides of sodium and potassium. Products with melting points ranging from 40 to 750°C., with viscosities ranging from a centipoise to hundreds of poise, can be 'pastillated.'

Pastillation is an elegant process by which the natural drop-forming tendency of a melt is induced under closely controllable conditions. The principle is to interrupt the flow of the molten product mechanically so that the stream of liquid forms separate drops. These drops are deposited on to the cooling surface in such a manner that the drops retain their shape without flattening.

The product is piped to the pastillating vessel which is heated to an appropriate temperature and fitted with a set of specially designed annular nozzles in its base. A plunger reciprocates through each nozzle so as to split up the flow of liquid into separate drops which are deposited by the plunger at the bottom of its stroke on to a cooled, slow-moving, endless steel band travelling underneath. The rate of reciprocation can be varied to give different pastille sizes as required. Due to a rapid heat transfer the deposited drops quickly solidify into nicely rounded pastilles or pellets, which fall off the band into the discharge chute as it flexes over the terminal drum.

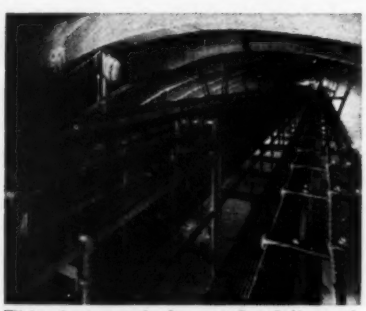
Advantages claimed for the *Pastillator* are:

(1) The molten product is solidified rapidly into pellets in one operation.
(2) No dust or powder is produced during pastillation as is formed on drum flakers.
(3) A free-flowing product, consistent in size and shape, is obtained.
(4) Pastilles have shown many advantages if the product has to be dissolved.
(5) Noxious substances may readily be pastillated in totally-enclosed, gas-tight *Pastillators*.
(6) Hygroscopic or easily oxidised products are most conveniently pastillated in a controlled atmosphere.
(7) Chemicals with a tendency to supercool may be pastillated.
(8) No metallic or other impurities are introduced into the product during pastillation.
(9) Very low power consumption.
(10) No operating personnel are required.
(11) Apart from occasional lubricating, little maintenance is required.
(12) Compared to a flaked product, pastilles have a higher bulk density and this reduces packaging and transport costs.

Chemical spray in coal handling

It has been found that, in handling, transporting and tipping coal, the dust nuisance can be eliminated by spraying an aqueous solution of calcium chloride on the coal. A Dutch firm Machinefabriek v.h. de Weger n.v. has produced a mobile spraying machine which consists mainly of a pumping unit provided with control cocks and pressure gauge, and a tank to hold the liquid, both being mounted on the chassis, while the spray nozzle is connected to the pumping unit by a flexible tube. The tank holds sufficient liquid to treat about 50 tons of coal, which takes about 5 hr. The manufacturers supply, for use in the machine, a calcium chloride solution which contains a special additive to ensure efficient wetting.

The mobile machine makes it possible to treat coal in trucks or dumps on railway sidings. For large storage yards it is also possible to design a fixed-line system with a series of nozzles and taps to which the machine is centrally connected.

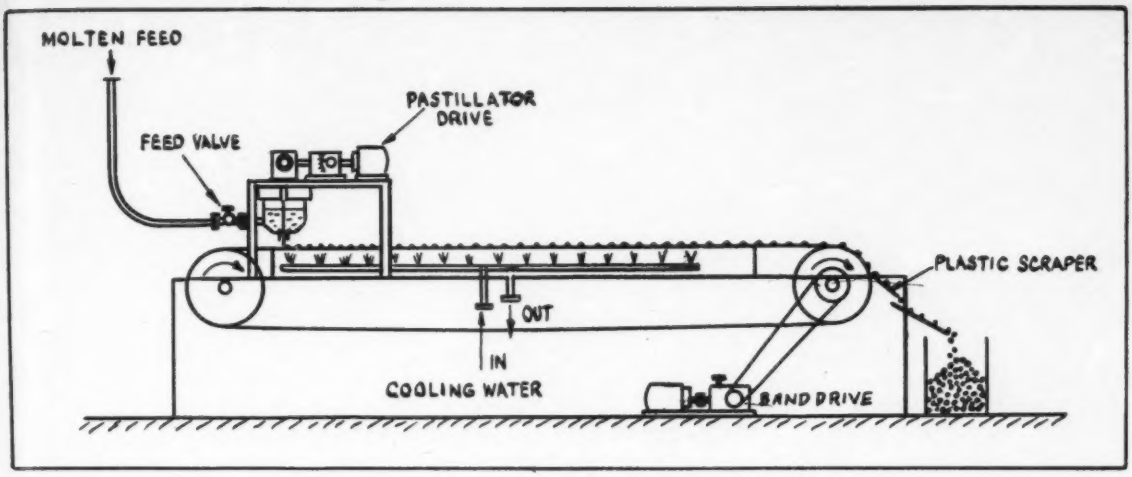


This photograph shows a Sandvik steel-band conveyor in an industrial installation (see opposite page).

Automatic feeder

A method of feeding material of a dry nature to grinding, pulverising or mixing plants is provided by the *Lea-Bar Vibra* feeder, in which vibration is effected by an electro-magnet with variable amplitude control, the stroke being varied to suit the product: long strokes for lighter material and short strokes for dense granular material. The feeder is dependent for its action on a supply of single-phase alternating current at 240 v.

In most cases, the units are supplied complete with suitable controllers for connecting direct to a single-phase, 50-cycle supply, a rheostat being incorporated which gives almost infinite control up to the maximum capacity of the machine concerned. These controllers are arranged for separate mounting and can be either for use with the normal sinusoidal wave form of the alternating current, or this can be split by means of a half-wave rectifier embodied in the contoller, giving a sharp, interrupted action to the magnet. By this method, a longer, more effective stroke is obtained than



Schematic diagram of a totally-enclosed Kaiser-Rosin 'Pastillator.'

is possible with unrectified alternating current, and this is directly responsible for the positive action of the feeder.

The vibrator pulls the tray sharply back at each pulsation of the energising current; leaf and coil springs return the tray to its original position at a slightly lower rate during the 'dead' period of the magnet.

The design of the tray is such that the material falls vertically as the tray is pulled sharply backwards from under it. The material then takes up an advance position relative to the tray, by which it is moved forward under the reciprocating action of the springs. This cycle is repeated at high speed, causing the material to flow forward. Infinite variation in the rate of flow, from maximum capacity to a trickle, is achieved by adjustment of the rheostat.

W. S. Barron & Son Ltd. are the suppliers.

Pneumatic handling

A mobile pneumatic-handling plant of moderate capacity was recently demonstrated by Spencer (Melksham) Ltd., who state that the aim was to produce a mobile unit which, while being really manoeuvrable, at the same time has strength, reliability and a long working life.

The plant is designed to handle 50 tons/hr. of wheat (or *pro rata* for other similar materials) when the intake nozzle is sinking vertically and the material flowing freely, the intake pipe being 100 ft. long including a vertical direct lift of 50 ft. with one bend, and the delivery pipe 100 ft. long laid horizontally with not more than one bend.

A high-speed diesel engine is used as prime mover, but where a suitable mains supply is available an electric motor can be fitted instead.

Controlled flow for fine powders

Valves can be used to control the flow of fine powders. The *Sureseal* valve, a dust-tight, totally-enclosed valve, made by W. S. Barron & Son Ltd., eliminates dust nuisance and spillage. Remote control is effected by manually or electrically operated air valves.

Steel-band conveyors

Steel-band conveyors, which are used for bulk and packaged goods, have advantages in the chemical industry owing to the ease with which they can be kept clean and with which materials can be discharged from the conveyor at any point along its length by simple scrapers.

Sandvik Steel Band Conveyors Ltd. report the recent solution of a storage problem in the soap powder industry by the use of their conveyors. Packaging of the powder takes place during the 8-hr.-day shift whilst manufacture takes place over 24 hr. During the non-packing period the powder from the process is fed on to a steel-band conveyor which is 13 ft. wide and built up of five 32-in.-wide bands. Deep sides on the storage conveyor allow the powder to be built up to a depth of approximately 2 ft. 6in. at the sides and peaked towards the centre, and the conveyors, which have 150-ft. centres, each house 60 tons when fully loaded. The material is then unloaded at the appropriate rate to the packaging department.

Steel bands can be used in process lines for drying, heating and cooling, the solidification and flaking of liquid chemicals and the handling of hot materials.

Overload control for crusher plant

One factory was faced with the problem of preventing a continuous crusher from being overloaded when fed from a continuous conveyor. This would have meant the crusher becoming blocked and the electric motor cutting out, necessitating a complete stoppage of the plant and emptying the crusher. This was solved by monitoring the current taken by the crusher motor, which rose as the load increased. The maximum safe load on the motor corresponds to a certain current value, and a current transformer in the motor circuit causes an electronic relay unit to be actuated, cutting out the conveyor when the maximum load condition is reached. When the load decreases to a predetermined point, the conveyor is restarted.

According to Elcontrol Ltd., who supplied the relay described, it can be used for both underload and overload conditions, and to control the performance of any electrical device at preselected load conditions.

Level control

The level of material in hoppers and bunkers can be controlled by switches. The *Londex* hopper switch operates electrical contacts when bulk materials press against a diaphragm. The switch can be used for controlling the level of material in a container or for indicating it by controlling signal lamps or audible warning device, control of elevating and conveying machinery automatically in response to fluctuating level in a hopper, etc.

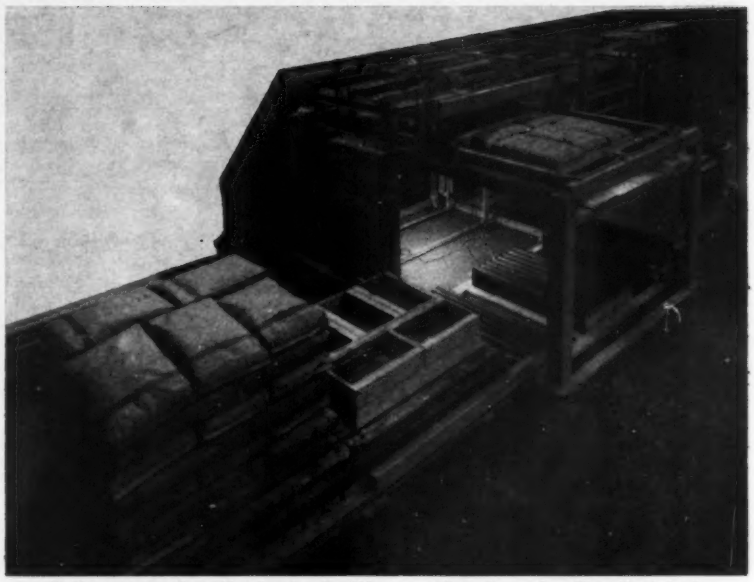
The same company, Londex Ltd., make a pressure-operated bunker switch which will operate contacts when the level of material in a bunker reaches or falls below a predetermined level. It is suitable for heavy or abrasive materials, such as coal and also where extreme conditions of dust and moisture exist. The switch is mounted into the side of a hopper in the vertical or near-vertical plane. When the level of material reaches the switch the pressure exerted on the face pad is transmitted *via* a liquid in the main housing to the bellows-operated pressure switch. Snap-action silver contacts then operate.

Pumping powders

The conveyance of dry powder through pipelines or totally-enclosed trunking has the advantages of providing a neater and more simplified form of production flowline and reducing the tendency for powder to disperse into the confines of the factory. In addition, ring main systems of piped powder with intermediate valve-controlled draw-off points can provide a practical answer to problems of discharge of powder at various stations.

Among the various powder-conveying methods developed in recent years is the technique of fluidising powder by air injection, and this has helped in the development of the *Mono* powder pump, the essentials of which are a metal rotor in a stator of resilient material. As the only moving part in contact with the powder to be conveyed is the metal rotor, the system is simple and easily maintained.

The rotor maintains a constant line of seal between the intake and discharge ends of the pump. This seal is continuously moving at a uniform velocity through the stator and recreating itself at the inlet. This has the effect of producing a positive and uniform rate of displacement which smoothly generates the flow of the powder for discharge through long lengths of pipeline. The relatively low velocity of flow prevents much of the compacting which is encountered when handling powder and consequently the pump can be used for conveying through pipelines involving a number of changes in direction. In addition, the pressure of the discharge from the pumping element reduces the amount of air needed for the delivery pipeline to a volume sufficient only to maintain the powder in a fluidised state, removing the necessity of separating excess air from the end product. Mono Pumps Ltd. are the makers of the unit described.



Fully automatic pallet loader by Western Manufacturing (Reading) Ltd.

Troughing-idler conveyors

Another form of conveyor, using a *Flexiroll* troughing-idler system, is made by Fisher & Ludlow Ltd. The troughing roller assembly comprises a spring steel shaft located to hollow stub axle ends, on each of which is mounted a mild-steel trunnion and a shock-absorbing compression spring. The spring steel shaft has an initial set which provides a shallow trough enabling rigid belts to make contact with the face of all rollers when the belt is running light and, as the load increases, the depth of the trough correspondingly increases, always following the natural catenary of the belt.

The 4-in.-diam. *Flexitex* supporting rollers, produced from a moulded plastic and canvas material, have graphite-impregnated nylon bearings which do not require lubrication. Fitted between each roller is a nylon-graphite-impregnated distance piece which maintains a positive connection between all rollers. All bearings are protected from the ingress of foreign matter by fireproof dust seals and belt tracking is controlled through offset trunnions carrying the flexible steel shaft.

The conveyor system is of pressed-steel construction comprising light but rigid units incorporating adjustable legs which facilitate the levelling and lining up of the conveyor and eliminate the cost of precast concrete blocks or other materials. Each structure can be quickly dismantled into convenient size units for transport underground.

For existing conveyor installations a *Flexiroll* troughing-idler frame is available as a standard unit suitable for bolting direct to the conveyor structure.

Easier conveyor maintenance

Beneath the floor of an I.C.I. Ltd., Nobel Division, plant run conveyor trenches, which are covered with mild-steel plates, each about 3 ft. square and weighing 1½ cwt. The lifting of these plates was a strenuous task for two men and, at times, a dangerous one since the plates were so unwieldy that there was always a risk of them being dropped.

The plates are now handled with the help of a specially designed barrow with extended shafts and forks. To lift the plates, the forks of the barrow are engaged with the rings specially fitted into the plate. The barrow is so balanced that one man can lift and move the plate even with two men standing on it without great effort.

Ice-distribution carousel

A distribution 'carousel,' designed to keep a constant supply of ice available for virtually immediate delivery to four gravity chutes, has been developed, manufactured and installed for the Clayton Aniline Co. by Simon Handling Engineers Ltd. Ice in briquette form is taken from two storage hoppers by the carousel and distributed on demand to any of four gravity-chute systems leading to unloading points situated in various parts of the building.

The carousel consists of a circular steel framework on which are mounted

12 stainless-steel tubs. The carousel is in constant rotation at a low speed and the tubs, which have open tops and ' drop ' bottoms, pass beneath two loading chutes and over four unloading hoppers.

Each of the tubs is mounted on a compression-spring seating so that as it is filled it sinks on its mounting. A trip trigger is fixed on each tub in such a position that as the carousel revolves the triggers of full tubs will pass beneath a system of levers controlling the loading-chute operating valve mechanism. The trip trigger of an empty tub, however, operates the lever system and ice is fed into the tub as it passes slowly beneath the chute. When approximately 500 lb. of ice has been loaded into the tub the trigger sinks below the lever mechanism owing to the compression of the springs and the feed is cut off.

The unloading of the tubs is controlled from any of the gravity-chute system delivery points on the floors below. When a supply of ice is required at any point, the operator positions a container beneath the chute outlet and presses a push-button. This causes a solenoid valve at the head of the chute to erect a trip switch which intercepts the next full tub on the carousel. The drop bottom of the tub is unlocked and ice is delivered through the hopper into the chute. The drop doors are then automatically closed and the tub receives a fresh load of ice when it reaches the next loading chute.

If there is a lull in the demand for ice the carousel will continue to revolve with all 12 tubs loaded.

Automatic pallet loader

Where the height of stacks can be increased, more efficient use can be made of the floor area. A fully automatic pallet loader, manufactured by Western Manufacturing (Reading) Ltd., can be installed in the output conveyor line to accept the bags or containers from the flowline and, in the case of bags, to pass them through a vibro-flattening unit installed prior to the actual loader.

At the loader, an empty pallet is ejected from a pallet dispenser and offered up to the arranging position where it receives each layer of containers correctly and accurately positioned. This process repeats itself for every layer, the pallet automatically adjusting itself each time to accept the new layer.

When the pallet is fully loaded it is moved from the machine by a powered roller conveyor on to a free roller section to await its removal by fork-lift truck. An output speed of up to 1,000 sacks/hr. can be obtained.

Stackers

A hydraulic barrel stacker, equipped with tubular forks and designed to lift drums weighing up to 700 lb. directly off the ground to a height of 56 or 75 ft., and therefore useful for loading and unloading vehicles as well as for stacking, is made by Powell & Co. The *Vertolifter's* masts are of heavy steel-channel construction and all moving parts have ball or roller bearings. Power is provided by a two-speed hand hydraulic pump; alternatively the pump can be driven by three- or single-phase mains electric motor or by a 12-v. motor and heavy-duty traction battery.

The truck is easily manoeuvrable, with two wheels in front and two castors at the rear, and is available with detachable platform for use as a normal lifting truck when not required for drums.

Racks to hold six or nine standard drums, from which individual drums can be removed without disturbing the others, are available for use with the stacker.

Lightweight pallet

A development by the Dyestuffs Division of I.C.I. is a cheap, lightweight, rigid pallet of the sleeve type, now being marketed under licence by Thomas Manning, Sons & Co. Ltd.

The *Manjute* rigid pallet is intended for handling by fork-lift truck, operating with the forks inserted in the sleeve units. While designed specifically for palletisation of bagged products, it is also suitable for other types of packages, such as fibreboard and wood cases and drums, with flat tops and no major recesses, protrusions, battens, etc.

Each pallet, which is claimed to cost less than the conventional wood or metal pallet, consists of two welded steel-mesh sleeves, two fibreboard covers for the sleeves, and two or more wood deck pieces, normally made from 3 in. × 1 in. planed softwood, each fitted with two sets of blocks screwed to the underside of the board, for positioning over the sleeve units.

In the welded mesh structure forming the sleeve, the steel wires running the length of the sleeve are all on the inside, thereby preventing fouling of the lateral wires of the sleeve by the fork of the lift truck.

Cranes and hoists

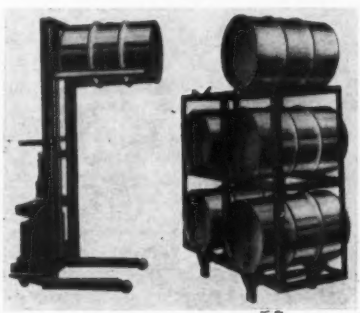
A new crane going into production is the *Iron Fairy* Mark 6 hydraulic mobile crane of 6 tons' capacity. This crane is meant for jobs where the distance travelled is great in relation to the vertical lift. When loaded it can travel at 5 to 10 m.p.h. and unloaded it will reach 20 m.p.h. It is able to pass through quite narrow passages and openings 9 ft. high; thus it can take loads directly into the stores or machine shop.

The four-wheeled chassis has only two tracks to consider and so surface obstacles can be easily avoided. Lengthy objects such as timber or steel pipes can be slewed round lengthwise besides the driver. The load never swings over the operator, who has it in full view all the time. Hydraulic relief valves will not allow excessive loads to be lifted. The crane is made by British Hoist & Crane Co.

Sling for awkward loads

A sling, designed for handling loads of unusual size or shape, and of unbalanced weight, can be used in confined spaces and will lift at almost any desired angle. The unit has a V-groove with a spring-mounted roller imbedded, over which the wire-rope sling rides. When the sling legs are secured to the load and the lifting starts, the sling legs lock automatically. After the sling is hung on the crane hook, the crane operator moves it to a point over the approximate centre of gravity. The legs are hooked

' Iron Fairy ' mobile crane.



Powell barrel stacker.

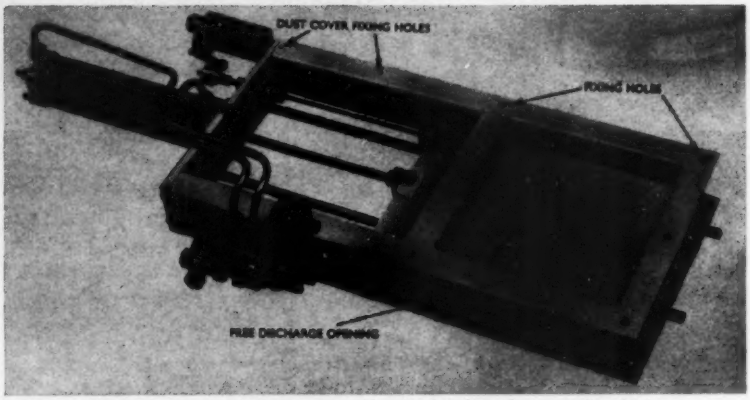
to the load and adjust themselves to the proper length as the lifting starts. As the load pressure increases, the weight frictionally locks the legs and the load is carried level. If the operator misses the centre of gravity, he lowers the load to release the brake action; he then moves the crane to the corrected position and the sling legs readjust themselves. Loads can be carried at almost any desired angle —after the sling legs are once attached the crane operator does the rest. The manufacturer is Felco Hoists Ltd.

Earthmoving vehicles in materials handling

Equipment designed primarily for earthmoving, *e.g.* bulldozers, scrapers and front-loading shovels, can often be applied to the handling of bulk materials with little or no modification. Job factors need careful consideration before finally selecting equipment. In many cases, a track-type vehicle will prove more advantageous in operation than its wheeled-drive counterpart. The handling of very dense materials such as iron ore, foundry slag or quarried material like granite are examples of the denser material being handled by track-type vehicles where the terrain offers poor traction. Here, successful penetration of the material to fill the bucket is dependent on traction. Weather conditions may affect the site with deterioration of footing or reduce the normal number of working days. The crawler tractor has superior flotation and tractor characteristics and these qualities enable it to work on the level and on adverse grades regardless of weather conditions. A further consideration is the space available for equipment manoeuvring. The crawler tractor's ability to execute pivot turns allow it to work in very confined spaces like ship holds or slag pockets. Where one or more of these factors is encountered, the crawler tractor is to be preferred.

One example of the use of earthmoving equipment for materials handling is an International Harvester Co. *Bullgrader* which has shown advantages in stocking out and reclaiming granulated fertilisers held in storage bays (see CHEMICAL & PROCESS ENGINEERING, 1958, **39** (10), 373). Other examples are in handling slag in steelworks, in quarrying work and in the disposal of colliery dirt.

The tramp steamer with the usual 'tween-decks tunnel holds long ends and deep wings, all of which contribute to the final discharge of iron ore cargo being slowed down owing to these places being inaccessible to the grab. An International B-6K-3 *Drott* skid-shovel with a *Drott* four-in-one bucket has solved this handling problem. A slight modification to the bucket by the provision of a stay permits the bucket to perform two tasks, namely dozing and back-dragging in heavy materials. The unit has the required traction, manoeuvrability and stability, while the flat shoes eliminate the risk of damage to the ship's ceiling. Turn-around has been speeded up from 16 to 24 hr. for ships carrying 7,000 to 11,000 tons.



Electro-pneumatic flow controller by Lindars Automation Ltd.

New vibratory conveyor

A new type of vibratory conveyor is claimed to be cheaper than the conventional magnetic design and to have all the advantages of the magnetic conveyor (except that it has a fixed rate of feed), *i.e.* few moving parts, low maintenance requirements and silence of operation. It is particularly adaptable where very little headroom is available. Applications for which it is specially suited are those involving the simple transfer of material from one point to another; the feed can be stopped or started at will and, although the speed of travel remains constant, the level of material can be altered by means of a gate to control the amount being fed.

The conveyor, the length of which is adapted to customers' requirements, comprises a feed trough fitted with a pair of electric vibrators, one on each side of the trough. The vibrators are mounted with their shafts in a vertical plane but inclined at a specific angle to provide a feed of material in one direction along the trough. The makers, Sinex Engineering Co. Ltd., say that each conveyor can be supplied complete with base structure or with simple mountings for attachment to the customer's own equipment. The only moving parts employed are the rotors of the vibrators. Vibrators can be quickly replaced, if this eventually becomes necessary, by virtue of their four-bolt lug mountings.

Flow-control slide

Material flow can be controlled with electro-pneumatically operated slides. Units are of mild-steel construction and are available with air cylinder, solenoid-operated air valve, open- and closed-position detection switch, and an air-release valve for emergency hand operation and maintenance.

The design is claimed by the makers, Lindars Automation Ltd., to preclude the possibility of jamming by the elimination of guides, the slide plate bearing on rods when mounted beneath conveyor outlets, and on rollers when mounted at bin or mixer outlets; easy fixing is ensured by double-flanged construction.

Company take-over

A. Gallenkamp & Co. Ltd. has acquired the business of J. W. Towers & Co. Ltd. by the purchase of all the Ordinary shares. The new board of directors is Mr. A. W. A. Rundle (chairman), Mr. J. S. Towers, Mr. J. P. Oldfield and Mr. H. F. Kirby.

*

An order for five sets of combined change-over and safety valves for the U.K. Atomic Energy Commission has been received by Cockburns Ltd.

The valves, for Windscale nuclear power station, are for service with radioactive carbon dioxide gas in the advanced gas-cooled reactor. Operating temperature is 760°F., and the valves, which have special alloy steel chests and internal parts, will be set to blow off at 280 p.s.i.

A CPE Chemical Engineering Review

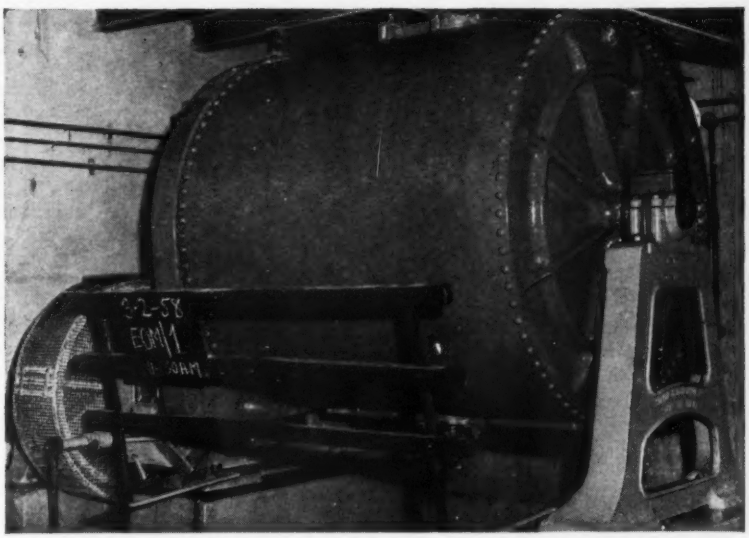
SIZE REDUCTION

Part 2.—Developments in ball mills, tube mills, fine grinders, refuse disintegrators; pelletising of plastics; grinding flour and coffee; meat mincing, etc.

By R. V. Riley, Ph.D., B.Sc., F.I.M.

THE first part of this article (December issue) discussed recent theoretical and practical advances in the size-reduction field and noted a number of new designs and improvements for crushing and grinding machinery, with some comments on materials of construction for gyratory crushers and on the grinding of particular materials such as ores and carbonaceous substances.

In this second and concluding part, developments in some further types of size-reduction machinery will be discussed while the very broad scope of size reduction will be illustrated by novel applications in the food, building-materials, domestic and other fields.



Porcelain-lined flint pebble mill used for the production of high quality enamels and flat paints in an Indian factory.

Ball mills and tube mills

A few practical studies of ball mill operation are reported.[109, 110] From observation of the grinding of taconite iron ore, it is concluded that larger, slower-speed mills are to be preferred for this application.[111] The specific power requirement of closed-circuit mills of four types was determined and found to depend directly upon the speed of rotation.[112]

Experiments with a full-sized air-swept tube mill working on Midland coal showed that up to a critical air flow the output continued to rise but when the air temperature within the mill fell until the coal failed to become dry, output again dropped. The only other variable of importance was the ball charge, an increase in which raised the power requirement.[113]

A particularly efficient coal-pulverising mill has a double conical grinding chamber,[114] whilst another cylindrical mill is divided into two or more chambers longitudinally.[115] A novel miniature tube mill has a magnetically attracted heavy cylinder as the crushing medium, the magnetic effect being obtained by an externally mounted electro-magnet.[116] The eccentric or compound movement ball mill[117] and out-of-balance vibratory type of mills[118, 119] have been described. The new R-N process for the direct reduction of iron ore incorporates ball mills which crush the iron ore to a fine degree of sub-division so that magnetic concentration can be applied.[120, 121] Self-regulation and automatic control[122] have been applied to wet grinding mills.

Helical mill liner bars, designed to preserve their original shape even when worn, have been described.[123, 124] Mill liners have been designed to help to retain the grinding balls in zones so that more than one degree of fineness of grinding can be achieved in the one mill.[125, 126] Rubber linings have been produced from a flexible band of rubber-coated steel,[127] and a Russian article[128] announces a ceramic lining fastened to the metal shell by a synthetic resin adhesive. Jar mills of varying sizes may be operated on the same roller bars spaced by separately adjustable rubber jar stops.[129]

For use in a ball mill, a new and improved grinding element is proposed;[130] its shape conforms approximately with the interstices within a group of four round balls symmetrically stacked. How long the new element retains this shape in the mill is not stated. An Indian inventor has proposed to use, as steel for ball forging, pieces cut from runners, the head portion of steel rails or from locomotive wheel tyres.[131–133] *Ni-hard* cast-iron balls have again featured in the grinding of enamels; they give a long life and a good result.[134] Ball wear can conveniently be measured by a radioactive tracer technique[135] and calculated by theoretical equations proposed by Bond.[136]

Ceramic balls of high density may be prepared from sintered material which has been pressed under high hydraulic pressures in a rubber mould.[137] Basalt, mullite or corundum-coated grog balls may be made having a high surface hardness.[138]

Fine-grinding mills

Colloid mills capable of extremely fine grinding usually employ high-speed rotor blades working at very fine clearances which develop a high degree of shear.[139] Naturally, these mills are built with the quality of a precision instrument and developments have been mainly in increasing the accuracy of construction which leads to more effective grinding. One method of controlling the degree of shear is to carefully apply air pressure to the operating surfaces.[140] To avoid damage to colloid mills, careful pre-grinding of the charge is essential.[141] Food, virus tissue, etc., is ground in successive stages of abrasion and finally by high-frequency vibration set up by fixed and moving contacting toothed surfaces.[142]

An interesting use of a colloid mill is in place of the conventional methods of stirring, in order to speed up chemical reactions.[143]

C. Toyne,[225] in an excellent short article on the grinding of dyestuffs, states that, although colours are in the majority fairly soft and easy to grind in a variety of mills, the very greatest care must be taken to avoid contamination. Heat-sensitive chemicals are also encountered and sometimes dyestuffs tend to be sticky. Fineness of grinding must always be carefully controlled and particle sizes of 10 microns are often required. One method proposed for the preparation of colours, paints, inks, etc., is to grind in a stainless-steel drum.[144] A new mill specifically for the grinding of pigments is claimed.[145]

Mechanised pestles and mortars appear to be becoming popular not only for laboratory purposes but for moderately large-scale grinding duties.[146] The Shandon electric mortar grinder[147] is now produced in three sizes—50, 250 and 1,000 c.c. capacity—with interchangeable pestles and mortars made of hard porcelain, tool steel and agate. In another design[148] the pestle and the mortar are driven in opposite directions and the pestle goes faster than the mortar. Other similar grinders of Russian origin include a planetary laboratory mill,[149] a spherical vibrating grinder[150] and a pulper used in alcohol production.[151]

Shurts[152] has claimed a newly-designed dispersion apparatus in the form of a high-speed stone mill for the fine grinding of paints which consist of already finely divided particles in a liquid medium. L. T. Work, a prolific American authority on size reduction, claims a novel fluid-energy grinding mill. The solids suspended in a vaporisable liquid are forced through a heating zone which gasifies the liquid and develops two gas streams which, when impinged one against the other, bring about the fine grinding of the pneumatically carried solids.[153] Another type of jet disintegrator is claimed in German patent literature.[154]

Refuse disintegrators

If invention is the forerunner of commercial development then there is shortly to be a tremendous boom in the manufacture of mechanical sink-refuse disposal apparatus which must result in this relatively new household article rivalling the refrigerator and washing machine in domestic snob value. Each slight variation in design is the subject of a separate patent application.[155–174] One interesting pattern employs a separate water jet directed at the crushing blades to clean the device after use.[175–176] The seal between the rotor driving shaft and the electrical gear has received special attention,[177, 178] as have the devices for ensuring reliable automatic operation[179–181] and maintenance.[182]

The more complete treatment of sewage in sea-coast towns has brought about the need for disintegrators which cut the solids to a greater degree of fineness.[183]

Pelletising

Thermoplastics like polythene and polyvinyl chloride must be prepared into pellet form prior to extruding into the finished article. One method is to extrude from an orifice a ribbon of plastic which, after cooling in water, is chopped into pellets by a rotor arm.[184, 185]

Flour grinding

For many years the roller mill has been preferred for flour grinding. Control methods giving infinite variation in the feed roll have been described.[186, 187] Interesting developments in the feed to the rollers are a specially designed scraper deflector[188] and a vibrating hammer which is supported wedge-like just above the nip of the rolls.[189] Its purpose is to guide the grain into the rolls and keep the roll crusher working freely.

A device for the cleaning of the grain before crushing,[190] a corn sheller[191] and a toothed roll crusher suitable for corn cobs[192] have been described. Noteworthy also are suction chamber screens,[193] pneumatic conveyors[194] associated with flour mills, and a new centrifugal impact milling process.[195]

Coffee mills

Coffee grinders are often specially designed disc mills or beater mills[196, 197] which run at high speeds and consequently tend to overheat. Since heat destroys the flavour of ground coffee, methods of water cooling the discs[198] or striker plates[199] are proposed. A new principle in coffee grinding is a shaped breaker roll working against grooves in a stout sieve cloth. The crushings from the beans are pressed through the sieve by the breaker bars on the rotating roll. It is claimed that a production rate of 400 to 500 lb./hr. of coffee less than 0.5 mm. mesh is possible.[200] A free-running coffee mill utilises air currents to keep the discs working well.[201]

Meat mincing

This year there has been a great deal of activity in the field of meat and animal carcass disintegration. The old mincing machine has had many improvements; the perforated disc and cutting knives still remain the main principle of cutting up both raw and cooked meats and developments have been mainly directed towards increased speed and control of size[202–205]

Electric mortar grinder by Shandon Scientific Co. The standard mortar and pestle are made from hard porcelain which is suitable for a range of materials from soft chalk to clinker, glass, coke, fireclay, etc. Very hard materials are ground in steel or agate. The illustration shows the 250-ml.-capacity grinder which operates with a 440-v., three-phase, 0.33-h.p. motor and weighs 240 lb.

which may be achieved in part by providing more cutter discs, each giving only part of the reduction in size. The worm feed screw in some machines has been replaced by gravity feed[206] and suction applied at the discharge end or a piston and cylinder principle which can be operated manually.[207]

Poultry meat may be recovered from the carcass after part cooking in a modified disintegrator mill followed by a flotation operation when the meat floats and the bony material sinks.[208] The same sequence in a slightly modified mill is claimed to be equally effective for sea food preparation.[209] The disintegrator mill is also applied to whole animal carcasses for the recovery of fats[210] and the production of fish meal.[211]

Other applications of size-reduction machinery

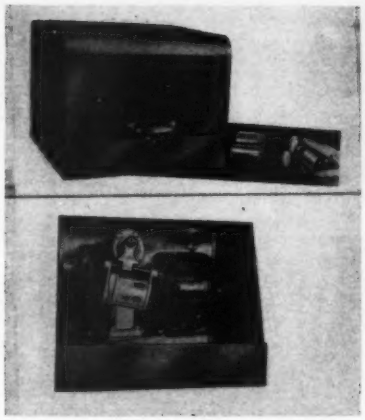
The hammer mill appears to form the basis of new equipment for breaking up ice blocks,[212–214] but for ice shavings a cutter disc is proposed.[215]

Size-reduction equipment and a review of recent developments in grinding and grinding machinery in the fine-chemicals industry were featured in the *Manufacturing Chemist*.[216] The grinding of substances which are non-brittle pliable solids at room temperature can be aided by the technique of cooling by refrigeration to below the ductile-to-brittle transition temperature.[217, 218]

A machine for powdering asbestos and similar fibrous matter comprises a rotating inverted cone having projections which break up the texture of the fibres and the light material produced is carried by a current of air from the top of the mill.[219] The 'flapper' mill for reducing the size of expanded grains of vermiculite is a specialised application of the age-old principle of winnowing.[220] The flapper arms are attached to a horizontal shaft which rotates in a cylinder; the blows administered by the 'flappers' give the broken grains a forward direction along the mill. A rather similar centrifugal process for producing flat wood shavings has been patented.[221]

Vibration grinding has proved ideal for the production of fine magnesia powder having high bulk density.[222] Such material forms a starting point in the production of high-quality sintered refractories.

At the other end of the scale, vibrations resulting from very high-frequency electromagnetic fields have been applied in Russia to disrupt iron ore. Ore lumps up to ½ ton in weight have been broken up in this way.[223] A special application of explosives for pulverisation purposes has also been claimed.[224]



This laboratory mill by Glen Creston Ltd. can pulverise 10 to 15 ml. in a single load. A charge of coarse sand may be ground to less than 300 mesh within 30 min. To avoid metallic contamination, plastic balls and vials are provided. The mechanism is totally enclosed in a sheet-metal housing which damps out vibration. The time cycle may be preset.

Publication

A wealth of knowledge is condensed in the card index records of the British research organisations comprising the Department of Scientific and Industrial Research. When these records are studied by able investigators, the result is an outstanding contribution to the literature. Such is the recent H.M.S.O. publication on crushing and grinding.[225] The work is in two parts, a series of short reviews of various aspects of the subject being followed by a bibliography with 2,831 references prior to 1956. Ten well-known British authorities have combined to produce this informative book on theoretical and practical matters, a useful starting point for the student and a handy reference for the specialist.

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Company News

Glass-fibre production at a new £750,000 plant at Camberley, Surrey, has been scheduled to begin in January. This represents the first phase of a considerable capital expenditure programme by Glass Yarns & Deeside Fabrics Ltd., an associate company of Microcell Ltd., and the plant will have one of the most extensively equipped research establishments in this particular field.

The full scheme of expansion will ultimately cover an area of 250,000 sq. ft.

*

The activities of Head Wrightson Processes Ltd., a subsidiary of Head Wrightson & Co. Ltd., have been extended to cover all the company's nuclear research and nuclear power interests.

With headquarters at Yarm-on-Tees in Yorkshire, Head Wrightson Processes will be responsible for carrying out the work at Bradwell and Latina nuclear power stations in addition to the research reactor projects in Denmark and Germany. With a London office, the company will continue to design and manufacture industrial cooling equipment, water-treatment plant and specialised chemical plants.

In August, Head Wrightson in association with Arthur G. McKee of Cleveland, Ohio, formed McKee Head Wrightson Ltd. of Baltic Street, London, to design, engineer and construct oil refineries and allied petro-chemical plant.

*

Forth Chemicals Ltd., manufacturers of monomeric styrene, have approved an expansion of their plant at Grangemouth, Stirlingshire, which will increase capacity to about 50,000 tons p.a. in a year's time. The company is owned two-thirds by British Hydrocarbon Chemicals Ltd. and one-third by Monsanto Chemicals Ltd. British Hydrocarbon Chemicals is itself jointly owned by the British Petroleum Co. Ltd. and the Distillers Co. Ltd.

*

Powell Duffryn Engineering Co. Ltd. has acquired the whole of the share capital of Pipeweld Ltd.

*

I.C.I. is to build a major extension to its trichloroethylene and perchloroethylene plants at Castner-Kellner works, Runcorn, at a cost of £1 million.

The extension will increase the company's combined capacity for these two solvents by 25%; it will enable I.C.I. to satisfy the demands of the home market for several years and permit an increase in its export trade.

The extension will be based on a new manufacturing process which is expected to lead to lower production costs. It will be completed in 1961. Initial reductions in the prices of the solvents were introduced on January 1.

*

An overall price reduction of more than 5%, effective from January 1, was recently announced by Q.V.F. Ltd. for their range of glass chemical plant and pipeline.

According to Mr. J. G. Window, Q.V.F. sales director, these reductions are due in part to reduced raw materials costs but more particularly to increased productivity, which has in turn produced sales expansion in all parts of the world.

Orders and Contracts

P.G. Engineering Ltd., a member of the Power-Gas Group, has recently agreed upon a contract with V/O Techmashimport, Moscow, for the complete supply of a plant for the production of polystyrene with a rated capacity of 5,000 tons p.a. The value of the complete plant supply is about £650,000 and delivery is scheduled to commence this year. The process design is to be supplied by BX Plastics Ltd., who have recently installed a new unit of this type. Engineering and supply of equipment for the complete plant will be by P.G. Engineering. Both companies will send engineers to the U.S.S.R. during the erection and commissioning stages of the plant.

*

P.G. Engineering Ltd. has also received instructions from the North Eastern Gas Board to build a plant, at the Whitby gasworks, to reform natural gas. The installation will be the first of its kind for this application in Britain.

The plant will comprise three two-tube P.G. *Hercules* furnaces (two working and one standby) and will be designed to produce a total of 1.25 million cu.ft./day of town's gas.

The natural gas will be obtained from wells on the nearby North Yorkshire moors and in the event of failure of this supply the plant will also be capable of producing town's gas by the reforming of commercial butane.

The plant is due for completion by July 1960.

*

Birwelco Ltd. have been awarded the contract for the supply of seven *Petro-Chem Iso-Flow* furnaces for the new Esso refinery in Milford Haven. The value of the order is more than £300,000. One of the furnaces is for the hydrofiner train and is of the all-radiant type. The duty is approximately 55 million B.Th.U./hr. The other six furnaces are for the power-former unit and have a total duty in excess of 300 million B.Th.U./hr. The largest furnace is operating with a duty of over 110 million B.Th.U./hr. This furnace is designed as a radiant separate convection unit to give an efficiency of about 70%. The shell diam. of this furnace is approximately 25 ft., and the stack is 150 ft. high. The remaining five furnaces have heat duties ranging from 60 to 110 million B.Th.U./hr. The Milford Haven refinery is being engineered by Foster Wheeler Ltd.

*

John Dalglish & Sons Ltd. have concluded a package deal with the U.S.S.R. worth over £500,000. The contract is for the manufacture, supply and erection of a series of machines for de-watering, drying, baling, wrapping and packaging of synthetic rubber.

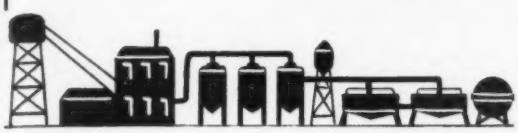
The fully-integrated plant will have an output of 70,000 tons p.a.

*

Items of chemical plant which include some of the largest all-plastics structures ever made are being fabricated by Cawley Plastics Ltd. to the order of a large chemical manufacturer. The material used is claimed to be the first combination of rigid PVC with a polyester resin-glass fibre laminate in which a true bond has been achieved. The contract is for a number of process towers and storage tanks made from dual laminate material, the largest single structure being a process tower 36 ft. high and of 4-ft. internal diam. Chemical storage tanks with capacities of 6,500 gal. are also included.

The dual laminate used consists of *Bakelite Vybak* industrial rigid PVC sheet, bonded to a strength-giving polyester resin laminate. The method of bonding employed is the subject of a patent application and details are not disclosed.

WHAT'S NEW



Plant • Equipment • Materials • Processes

CPE reference numbers are appended to all items appearing in these pages to make it easy for readers to obtain quickly, and free of charge, full details of any equipment, machinery, materials, processes, etc., in which they are interested. Simply fill in the top postcard attached, giving the appropriate reference number(s), and post it.

Hydraulic valve

A new valve is specifically designed for the hydraulic operation of heavy-duty clutch and brake mechanisms or any similar mechanisms which require constant manual control. Two advantages claimed by the makers, Keelavite Hydraulics Ltd., are:

(1) Increased movement of the control will give a corresponding increase in hydraulic pressure, providing progressive braking or declutching.

(2) The greater the hydraulic pressure applied to the actuators the greater the resistance felt by the operator.

Although the maximum pull required on the lever of this valve is only 18 lb., the full hydraulic pressure of 1,500 p.s.i. can be sensed and controlled. A given movement of the control lever will produce a resistance proportional to the movement of the hydraulic actuator.

There are three ' reduced pressures ' available: 0 to 500, 0 to 1,200 and 0 to 1,500 p.s.i. Port sizes are all $\frac{3}{8}$ in. B.S.P. The valves are available singly or in multiples up to six. Usually they are supplied in pairs for combined brake and clutch operation. They can be adapted for foot operation. **CPE 1406**

Self-priming pump

A new, vertical, self-priming centrifugal pump has been designed for general-purpose pumping duties and is suitable for handling clear or cloudy liquids up to 220°F., fuel and diesel oils and other oils up to 450 sec. Redwood No. 1 and, the makers say, can be used to handle volatile liquids.

The pump primes quickly, the dynamic suction lift amounting to as much as 28 ft. when pumping cold liquids. The capacities and heads available are 70 gal./hr. at 100 ft. of liquid and 400 gal./hr. at 25 ft. Occupying less than 1 sq ft., the pump incorporates several new features. The casing is designed so that, if the foot valve on the suction line should be inoperative the pump will continue to work. The impeller is specially shaped and is fitted with very short blades to prevent breakage on bending, and is also fixed so that it is not in contact at any point with the casing and there is consequently no wear on the impeller. The pump and motor shafts cannot become misaligned since they are rigidly coupled by a new type of split coupling.

For further details contact Precision Electrical Products (Stockport) Ltd. or fill in the reply-paid postcard. **CPE 1407**

Glass valve for use with corrosive liquids.

Glass valve

A screw-type glass valve, suitable for use with corrosive liquids, is announced by Q.V.F. Ltd. The 1-in. valve features a *Fluon* bellows with glass-fibre loaded *Fluon* seat. The bellows eliminate the need for any form of packed gland. Maximum operating pressure is 50 p.s.i. **CPE 1408**

Air heaters

For oil-fired air heating a new range of industrial heaters has been introduced which is claimed to embody a fundamentally new system of combustion air supply. Advantages claimed for this design include the reduction of excess-air requirements to a minimum, the achievement of complete combustion in a space less than 15 in. long, and the avoidance of deterioration in the chamber walls due to flame impingement.

It is stated that the preheating of the combustion air and the reduction in excess air makes it possible for temperatures of over 3,000°F. to be achieved throughout the chamber as against an average temperature of 1,600°F. in the conventional chamber. At this temperature every particle of oil mist is evaporated so that sooting—the incomplete combustion of the fuel—is eliminated.

These *Turbo-Static* heaters, manufactured by Colt Ventilation Ltd., are neat and clean in appearance, all controls and components being concealed beneath the casing. **CPE 1409**

Not so shocking

Extra safety for operators using low-voltage portable electric tools and handlamps is claimed for a range of low-voltage transformers in *Fibreglass* cases, produced by Sturdy Electric Co. Ltd., while corrosion resistance is a further advantage. It is stated

that the high impact strength of the material used for the case enables it to withstand the rough usage to which portable transformers are subjected.

To eliminate the usual fixing methods the cases are filled with sufficient bitumastic compound to cover the core and windings. This effectively secures the transformer inside the case and in addition provides a seal against atmospheric conditions. At the same time it avoids a source of potential danger to the operator from metal parts which might become alive. Nylon screws secure the lid and the primary cable gland is also of nylon.

CPE 1410

You can have it all taped

When pipes have received their protective covering of paint they are usually identified by plain rings of colour painted at set intervals. This is satisfactory when the contents to be established are only few. Invariably codes and symbols are also required offering more detailed information. John Gosheron & Co. Ltd. are offering two-ply pipe tapes which carry out this procedure quickly and inexpensively.

The tapes, which conform to B.S. 1710, cover both basic colour and detailed identifications of pipelines. Identification of actual contents is achieved by a tape printed with the appropriate words or symbols. Direction of flow of fluids can be indicated by tape printed with arrows from 3 to 6 in. long. The tape consists of printed cellulose tape laminated with either ethyl cellulose or thin vinyl tape.

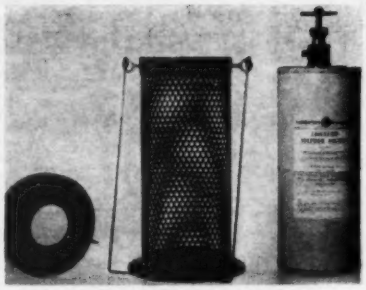
CPE 1411

Treatment in hot baths

A new treatment which provides a protective chemical blanket for hot immersion processing baths is offered by Pyrene Co. Ltd. The *Heat-Lok* treatment consists of two integral components, the sealant, forming a protective blanket on the surface of the processing bath, and the additive which is a surface-activing agent in the processing solution itself. The manufacturers claim that the treatment has no harmful effect on the coating characteristics of the processing solution and that, in fact, it frequently increases the efficiency of the process, tending to produce more complete and uniform coatings.

The additive is replenished in direct proportion to the amount of replenishing chemical used for maintaining the specified concentration of the processing solution. The sealant is added as required to maintain a chemical blanket of approximately $\frac{1}{2}$ in. on the surface of the solution. The advantages claimed for the treatment are greatly reduced heating costs, improved working conditions and a reduction in equipment maintenance.

CPE 1413



SAFER SIPHONS

The photograph shows a guard for siphons of liquefied sulphur dioxide, which are now received by the user enclosed in a cylindrical cardboard container fitted with a metal top and bottom, and filled with sawdust. The container gives a measure of protection and is not meant to be removed. Some extra degree of protection seemed to be indicated so this guard was devised by the Akers Research Laboratories of Imperial Chemical Industries Ltd. Even if the siphon container is damaged or softened by careless treatment, it can still be placed inside the guard, which acts as a convenient means of carrying the siphon.

The guard is 12 in. high and is made from 20-gauge, perforated mild-steel sheet, 16-gauge mild-steel sheet and $\frac{1}{8}$-in. mild-steel rod. The inside of the base is covered with $\frac{1}{8}$-in. rubber sheet.

CPE 1412

Solvent-recovery processes

Activated-carbon solvent-recovery plants incorporating the following Lurgi processes are now to be made available in the U.K. by Chemical Engineering Wiltons Ltd., under an agreement with Lurgi-Gesellschaft für Chemotechnik mbH., Germany:

The *Supersorbon* process for the recovery of solvent from air.

The *Benzorbon* or *Supersorbon* processes for the recovery of hydrocarbons from coke-oven gas and town gas or from natural gas and reformed gas.

The *Desorex* process for the purification and desulphurisation of all kinds of gases.

The *Hydraffin* process for the purification of water (*e.g.* dechlorination, deodorisation, etc.). **CPE 1414**

Portable mixer

A portable unit, the *Pioneer* mixer, capable of mixing batches of 25 to 1,000 gal., is offered by Premier Colloid Mills Ltd. Although the mixer is available on a mobile stand, it is also suitable for clamp mounting, which gives universal movement so the mixer head can be correctly positioned in the mix. It has been designed for use at high, medium or low speeds.

It is totally enclosed and flameproof and there are various motors available both for single- and three-phase working from $\frac{1}{2}$ to 1 h.p., ranging from 400 to 3,000 r.p.m. The built-in 'reduction' gearbox for the slow-speed unit is integral with the motor casing and is so small that it makes little difference to the weight or overall dimensions as compared with the directly driven unit. This design also ensures that the motor and mixer shaft are co-axial.

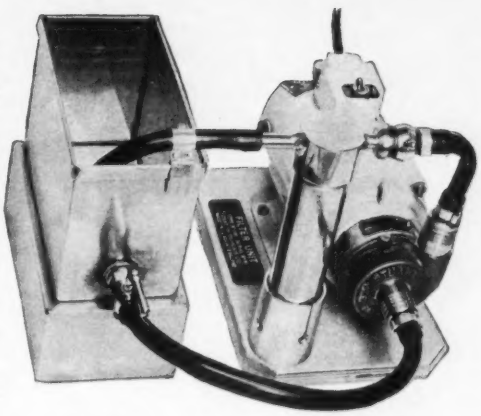
Portable mixer.

The gearbox, which runs silently, is fitted with non-metallic gears, obviating the need for an oil bath, and is claimed to require only very occasional maintenance.

Dependent on speed, this mixer is available with a patented *Dispersator* or stainless-steel marine-type propellers. **CPE 1415**

Filter unit

A filter unit offered by Dawe Instruments Ltd. provides for the continuous removal of solid matter from ultrasonic cleaning baths of their own or other design. Fluid is drawn from the bottom of the cleaning bath by a centrifugal pump and returned to the top of the bath by way of a filter having a sintered element of stainless steel, which is claimed to be capable of removing all solids down to a size of below 2 microns from 8 gal. of liquid/hr. **CPE 1416**



Filter unit for ultrasonic cleaning baths.

Radiation detector

To detect plutonium at maximum permissible body burden level or even less, Plessey Nucleonics Ltd. have developed a mains- or battery-operated portable instrument which is essentially a detector of low-energy gamma radiation.

As well as being capable of detecting minute amounts of plutonium 239 in the human body, with slight modifications and recalibrations the instrument can also detect the presence of americium or uranium 235.

The complete equipment consists of a detector probe connected to an indicating unit by up to 6 ft. of cable. Sensitivity for direct plutonium radiation is 15 c/s per microcurie and about 0.2% of this figure for background radiation. Maximum permissible body burden of plutonium located at one point gives about five times the background count through 1 cm. of human tissue. **CPE 1417**

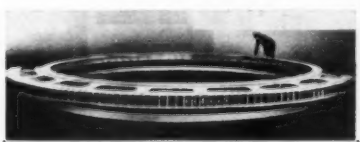
Leak-tight pipes and equipment

Advantages claimed for the *Ruston-Grayloc* high-pressure pipe connections are that they are lighter and smaller than conventional, bolted, flanged connections for a given duty and can be made and broken rapidly and repeatedly, using the same seal member.

The connection has three main components: (*a*) a metal seal member consisting of a rigid ring with a tapered shoulder on each side to form sealing lips; (*b*) hubs machined with a taper seat of slightly greater angle to mate with the seal member lips; and (*c*) a two- or three-bolt clamp. It is available in a standard range from 1 to 30 in. to suit pipes prepared for butt-weld, socket-weld or threaded connections. Butt-weld and socket-weld hubs are available throughout the complete range and threaded connections are available up to 8-in. pipe size.

On assembly, the seal member and its hubs form a line seal as soon as they touch. As the clamp is tightened during assembly the lips of the seal member deflect, within the elastic limit, to form a surface seal with the mating hubs, the sealing force being provided by the stored energy of the stressed seal member. Once the surface seal has been made, the connection will withstand high internal and external pressures, as well as vacuum. When high internal pressures are applied the sealing force is increased.

The suppliers, Ruston & Hornsby Ltd., say that the sealing principle can be extended by special design to provide extreme leak-tightness in such diverse applications as closures for autoclaves, heat exchangers and for connections throughout hydraulic and steam systems. **CPE 1418**



GIANT BEARING

The illustration shows a wire-race ball-bearing of 22-ft. diam., recently supplied for a calcium carbide furnace. Similar bearings for arc-melting furnaces and other applications are available from the Roballo Engineering Co. Ltd. **CPE 1419**

New joint for plastic pipe

A greatly improved process for flanging polythene pipe is claimed by Foster Bros. Ltd. They point out that, hitherto, joints on the larger sizes of polythene pipe have been made by means of welded-on flanges or welded joints of the spigot and socket type. These processes involve the use of high temperatures which can cause deterioration of the material and embrittlement, it is argued. Furthermore, there is no simple non-destructive test for polythene.

The *Bulldog* flange is the result of a process in which the flange on the end of the pipe is formed out of a double thickness of the pipe wall. The heating medium employs hot gas or vapour under strictly controlled conditions so that the temperature of the material is only briefly raised to the region of its softening temperature. The backing flanges used to make the joint can be mild steel (black or galvanised), malleable iron, stainless steel or non-ferrous, and an ample radius is provided at the back of the *Bulldog* flange to avoid stress concentration. The completed joint is wholly polythene-to-polythene (except for the joint ring, if used).

The flange is available in sizes of 1 to 6 in. and is normally used in conjunction with *Deltathene* high-tensile pipe, although the process can be carried out on most materials in the plastics range, including 'soft' polythene and rigid PVC. **CPE 1420**

Valve with something up its sleeve

A valve with all the advantages of the plug valve but none of the disadvantages is the claim for *Langalloy-Durco* type 'F' plug valve. The disadvantages are said to have been eliminated by use of a sleeve of PTFE between the body and plug. Designed by the Duriron Co. Inc., U.S.A., the valve is now produced by Langley Alloys Ltd. in the U.K. The valves are available in stainless steels and nickel, and other alloys. The PTFE sleeve has been developed to ensure suitability for operation at temperatures up to 400°F.

The main advantages claimed for the valve are: elimination of metal-to-metal contact, elimination of need for regular attention on site, no lubricant costs, no contamination of the product, ease of operation and ease of maintenance—a new sleeve can be fitted in a matter of minutes. **CPE 1421**

All very fine for processing

In processing very fine materials with rotary-louvre drying and cooling equipment, a new system of operation prevents the carrying away of fine materials by eliminating the current of air and effecting the heat transfer by heating or cooling sections of the internal louvres before they enter the bed of the material. When heating, a flame, or hot air, is applied directly to a number of louvres which, in turn, rapidly transfer their heat to the material. When cooling, sections of the louvres cooled by air successively extract the heat from the hot material.

This system of heat exchange by conduction can be supplemented by a small volume of hot or cold air passing through the material bed at a velocity to suit the fineness of the material being processed and, as the material does not at any stage drop through the air current, a negligible amount of fines is carried away.

This semi-indirect system can also be applied, during normal rotary louvre operation, to the processing of materials in the form of large crystals in order to obtain an additional heating or cooling effect by pre-heating or pre-cooling the louvres before they enter the bed of the material.

For processes requiring high temperatures, such as 350 to 500°C. at discharge, the louvres are available in heat-resisting steel and the design of the equipment allows for the differential expansion which would be experienced in such cases.

Further details may be obtained from the manufacturers, Dunford & Elliott Process Engineering Ltd., or by making use of the reply-paid card.

CPE 1422

Taking a safe view

For viewing equipment and processes through sight glasses in pressure vessels, furnaces, chemical plants, etc., without danger of serious injury in the event of window breakage, a 'safety periscope' enables the observer to stand well clear of the window in a safe zone.

The instrument consists of a periscopic optical system of unit power with a field of view of 35°, fully corrected and free from distortion. The optics are contained in a metal tube 30 in. long and 1½ in. diam., fitted at one end with a rubber eye shield and focusing sleeve and at the other a 90° prism. Objects between 3 in. and infinity from this prism can be focused, with great depth of focus at any setting. A 90° eyepiece is available for use when the periscope has to be held horizontal at a level lower than the eye.

Safety periscope.

Low voltage, high-intensity spot lights are also available to fit on the end of the periscope for viewing equipment inside pressure vessels which are without internal lighting.

Makers: P. W. Allen & Co.

CPE 1423

★ *American Developments in Brief* ★

A new, low-cost flow indicator and alarm for purge-type service, seal-oil systems, bearing lubrication and cooling-water indication is offered by Brooks Rotameter Co. The electrical components of the alarm systems in some models can be arranged for 'make' or 'break' signals. The alarm controls are adjustable over the entire flow range of the meter. **CPE 1424**

★ ★ ★

New *Cowles Dissolver* models for mixing, dispersing and de-agglomerating, announced by Morehouse International, feature a new power-transmission system capable of delivering over 90% of motor h.p. to the impeller even at lowest speeds. The unit employs variable-pitch-diameter pulleys and belts to maintain maximum available h.p. at any selected speeds which may be changed during or between batches without appreciable loss of h.p. capacity. **CPE 1425**

★ ★ ★

Gelman Instrument Co. introduce a new, miniature, pressure-vacuum pump, developed for air sampling, but with many other uses. The pump has a capacity of 0.3 cu.ft./min. free air and weighs 5 lb. complete with motor. The vacuum mechanism is a small aluminium piston. Twin graphite rings on the piston maintain a vacuum seal and eliminate lubrication. The piston is direct coupled to a 1,600-r.p.m. split-phase motor. **CPE 1426**

★ ★ ★

A new catalytic process is available for processing aromatic light oils to obtain benzene, toluene and xylene. It is stated that the purified benzene obtained from the *Litol* process typically contains less than 1 p.p.m. of thiophene and has a freezing point of 5.4°C. or higher. Since catalytic dealkylation is also an integral part of this process, substantial additional quantities of benzene are realised from toluene and xylene contained in the aromatic light oil feed. Destruction of aromatics in this process is negligible, resulting in extremely high yield. The *Litol* process can be utilised for dealkylation of toluene, xylene or higher aromatics from sources other than coke-oven light oils to produce high-quality benzene or other more valuable aromatic products. Further information from Houdry Process Corporation or send in the card quoting: **CPE 1427**

★ ★ ★

For cleaning conveyor belts Stephens-Adamson Mfg. Co. offer a device which consists of a row of thin, spring-steel wiper blades, each with an individual pressure spring. The wiper blades are set perpendicular to the belt surface, but diagonal to travel of belt. Pivoted connections between blades and springs permit wiping edges of blades to seat uniformly on the surface of the returning belt. As the belt passes over the cleaner, each blade wipes a path clean and dry. As blades overlap, the entire carrying surface is wiped. **CPE 1428**

★ ★ ★

New lightweight filters free of built-in contamination have been announced by Purolator Products Inc. A new high-pressure process, using special dove-tailed construction, locks together all components of the filter element (including media, end caps and centre tube) so securely that the filter medium is embedded in the parent metal of the end caps to form a leakproof seal. Since the new process requires no welding, aluminium and dissimilar metals can be used in filter designs. **CPE 1429**

Pump hire brings costs lower

A plant hire scheme to enable experimental and test work to be carried out at minimum expense has been introduced by Metering Pumps Ltd. The plant available is a packaged unit of an electrically-operated variable-stroke chemical injection pump together with solution tank and fittings. The pump has an ebonite head with polished glass ram and synthetic rubber gland sealing rings. It can deliver from 0 to 3.75 gal./hr. against a pressure of up to 200 p.s.i. Six stroke speeds can be selected and length of stroke can be varied from zero to maximum. During hire, free service and technical advice will be available. **CPE 1430**

Pumps

Firth Cleveland Pumps Ltd. are to manufacture under licence the range of self-priming multi-stage centrifugal pumps designed and developed by Dickow-Pumpen, Western Germany.

The pumps can handle a wide variety of liquids and sludges at temperatures up to 250°C. They are available with any number of stages up to and including eight. Each stage develops a head of 100 ft. at 1,450 r.p.m. normal operating speed. The eight-stage pump therefore develops 800 ft. Capacities are from 25 to 1,000 gal./min. Efficiency is stated to be 82% and the pumps will handle liquids of medium viscosity.

The priming stage, which is of the regenerative type, is mounted after the pumping stages. It is claimed that this arrangement ensures that no

PVC expansion unit.

vapour-lock can occur in the pumping stages, which in turn eliminates the need for constant supervision of the pump.

The design of the priming stage is such that it will expel gas or air through discharge pipes which are full of liquid, and pointing downwards. The pumps can therefore be installed at any point in a system. In spite of this the pump is able to handle abrasive slurries, as the channels are so arranged that liquids from the pumping stages by-pass the priming stages, where tolerance is very close. **CPE 1431**

Testing boiler water

To prevent boiler water from becoming unduly concentrated a quick method of estimating the chloride contents of both the feed and boiler water is useful. Such a method is offered by Paterson Engineering Co. Ltd. in their chloride testing set. The approximate total of soluble solids contained in a sample of boiled water can also be rapidly ascertained by means of a hydrometer by the same company. **CPE 1432**

Stopcock

A new stopcock is offered by Loughborough Glass Co. Ltd. It has a PTFE key which needs no grease and will not seize even in the presence of caustics and it is easily assembled into standard apparatus as the barrel and side arms are made in *Pyrex* glass. The surface of the key has dimples which deform when the retaining cap is tightened, to give a seal suitable for medium vacuum work. **CPE 1433**

Anti-expansion policy

A method of overcoming the expansion problem encountered when plastic-pipe installations are subjected to temperature variations is claimed by Barflo Ltd. They have introduced an expansion unit the male end of which passes through an O-ring; this forms the main seal and allows telescopic action of the components contained in the cylinder. Auxiliary packing glands at each end of the cylinder enable repacking to be carried out, thereby prolonging the working life of the unit. The pipeline need not be interrupted when renewing the packing.

Expansion can be controlled over a movement of 2 to 12 in. according to the size of the unit employed. Installed pipe runs of sizes from $\frac{3}{8}$ to 6 in. i.d. are possible. Units are available in sizes beyond the standard range to meet special requirements.

The expansion units are constructed from PVC piping made by Durapipe & Fittings Ltd., using *Geon* RA 170 high-impact PVC which is made by British Geon Ltd. **CPE 1434**

Size Reduction

(*Concluded from page* 25)

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[199]U.S. Pat. 2,834,552.
[200]Brit. Pat. 757,607.
[201]U.S. Pat. 2,852,202.
[202]U.S. Pat. 2,878,846.
[203]U.S. Pat. 2,863,480.
[204]U.S. Pat. 2,841,197.
[205]Ger. Pat. 1,032,902.
[206]U.S. Pat. 2,836,825.
[207]U.S. Pat. 2,842,176.
[208]U.S. Pat. 2,858,222.
[209]U.S. Pat. 2,858,223.
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[215]U.S. Pat. 2,852,201.
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[217]U.S. Pat. 2,862,242.
[218]U.S. Pat. 2,836,368.
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[89]C. H. Chilton, *Chem. Eng.*, 1958, **65** (16), 116-119.
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[93]U.S. Pat. 2,848,516.
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£ s d

CHEMICAL PLANT COSTS

Cost indices for the month of November 1959 are as follows:

Plant Construction Index: 179.1

Equipment Cost Index: 166.3

(June 1949 = 100)

£ s d

Metals for the New Age

I.C.I. ADDS WROUGHT BERYLLIUM TO ITS PRODUCTION OF 'NEW' METALS

The beryllium plant recently brought into production by Imperial Chemical Industries Ltd., at their Witton works, near Middlesbrough, is the first in Europe to be designed for processing large quantities of beryllium from raw material to wrought product. It will operate as a research production unit with an initial output of about 7 tons p.a. Some notes on the plant appear below, together with some details of the associated titanium melting plant and zirconium plant.

THE commissioning of their wrought beryllium plant is the latest achievement in Imperial Chemical Industries' project to develop production of 'new' metals and creates a valuable source of supply for the United Kingdom Atomic Energy Authority, who will use beryllium for fuel cans in their experimental advanced gas-cooled reactor programme. So far, I.C.I. have spent £10 million on their metals project, which includes the production of titanium and zirconium as well as beryllium.

All three metals are in demand by the aircraft and nuclear engineering industries because of their special properties, and all three present the metallurgist with formidable production problems. They are difficult to extract from their ores and once the metal has been obtained it cannot be melted and turned into massive form by normal methods. Melting has to be carried out by remote control and in a vacuum.

Beryllium production

With beryllium an extra production difficulty arises. Powdered beryllium could affect the lungs if inhaled in excessive amounts, and so special precautions have to be taken in the new plant to ensure that workers are not exposed to this risk at any stage of the process. Dust must be strictly controlled. The level of atmospheric contamination tolerated at the Witton plant is 2 microgrammes/cu.m.

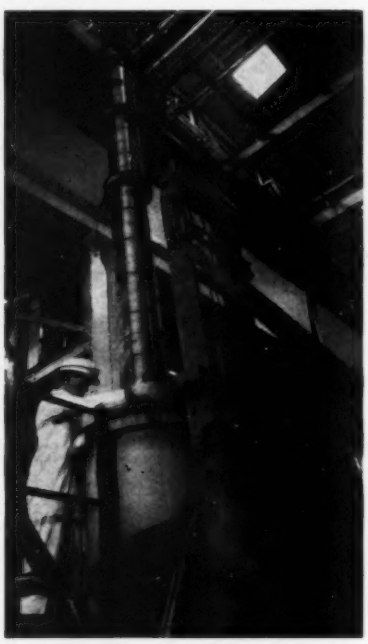
There are now windows in the plant and all incoming air is filtered, heated and then extracted through machine enclosures and special ducts. The air in the building is changed every 3 min., about 200 tons of air being moved every hour. All the air is filtered before being discharged from a chimney 150 ft. high.

Elaborate precautions are taken at every stage of processing to ensure that operators do not come into contact with beryllium powder and to guard against contamination of the beryllium.

To produce beryllium metal with superior mechanical properties, particularly in regard to ductility, powder metallurgy techniques must be employed. The cast ingot is therefore machined to swarf and this in turn is ground to fine powder. The powder is then packed into graphite moulds and sintered at high temperature under vacuum. Solid compacts produced in this way are either machined to finished size or prepared for further processing.

Rod and tube are produced by extrusion, particular care being taken to avoid seizing in the dies. This is achieved by plating the extrusion slug or enclosing it in a protective mild-steel sheath.

Careful design of equipment handling powdered beryllium ensures that air contamination is kept within the prescribed limit. Suction pipes working with a velocity of 10,000 ft./min. are provided immediately adjacent to cutting tools or other points of dust generation, and all machining operations are performed inside glove boxes from which air is automatically withdrawn. Special protective clothing and face masks are used during commissioning and for certain maintenance operations, but they will not normally be necessary for routine processes.



The titanium melting plant.

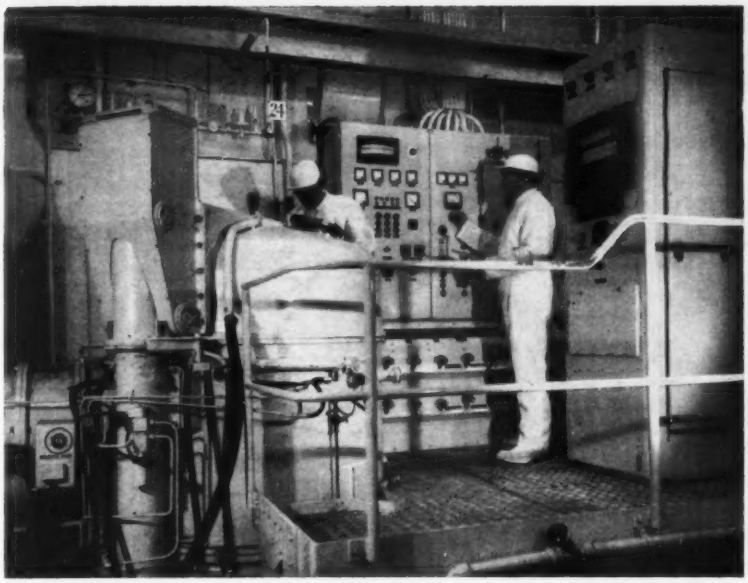
Titanium

Britain's first titanium-melting plant was commissioned at Witton in 1955. It drew its raw material from I.C.I.'s General Chemicals Division, who had developed a new process, the 'sodium route,' for extracting titanium. Since then, the pace of development at Witton has been spectacular. The latest giant furnaces can make ingots of up to 4,200 lb., compared with the original ingots of only 400 lb. The new plant has a capacity of 2,000 tons p.a.

Because titanium melting is subject to hazards not encountered with more conventional metals, all operations are carried out by remote control. Each furnace is built inside a massive 60-ft.-high reinforced-concrete cubicle, and before melting starts this is sealed by closing and locking a 10-ton door, so that even in an emergency there is no risk to plant personnel.

In modern titanium-melting practice, a consumable electrode is melted to form the ingot. This electrode is made from granules of raw metallic titanium, sometimes alloyed with other powdered metals. After double mixing to ensure thorough blending, a measured charge is fed into the die of a 2,500-ton press, which compacts the powder into a semi-cylindrical briquette. Briquettes are then welded together to make an electrode 12 ft. long and weighing almost a ton.

The electrode is suspended from the top of the furnace while the water-cooled crucible is clamped on at the



In the beryllium plant beryllium powder, produced by reducing the cast ingot, is consolidated in a sintering furnace prior to extrusion.

bottom. The furnace is evacuated, an arc is struck on to a small quantity of titanium powder in the crucible base and the whole electrode is slowly melted to form an ingot. To ensure complete homogeneity, the process is repeated. The ingot is raised to the top of the furnace, the crucible changed and the ingot remelted into a larger-diameter crucible.

The progress of melting is watched in the control room by means of an optical system which projects an image of the arc zone on to twin screens. Electrical and electronic devices supply continuous data on the operation of the furnace and ancillary equipment throughout the four or five hours needed to produce a 1-ton or 2-ton double-melted ingot.

Once the metal has been consolidated into ingot form, conventional metal-working techniques can be used, provided that attention is paid to titanium's inherent characteristics, such as oxidation behaviour, low rate of work hardening and tendency to gall on sliding contact.

When ultrasonic testing has checked freedom from flaws, the ingot goes to the forge for forming into flat slab or round billet. Heated in an electric furnace, the ingot is forged into shape by forging press or hammer. Shot-blasting and machining remove the dull outer layer of the forged product, imparting the characteristic silvery sheen of the wrought metal.

At this stage, most of the titanium produced in the Witton plant goes to the fabricating plant at Waunarlwydd, South Wales, where specially adapted rolling plant completes the processing of rod, sheet and tube. Other wrought forms—wire and extruded sections—are processed on plant normally used for conventional non-ferrous alloys.

Zirconium

The difficulties in melting zirconium are very similar to those experienced with titanium. Its melting point is even higher (1,852°C.) and its intense reactivity, particularly when molten, precludes the use of conventional furnaces and refractory-lined crucibles.

Fortunately, the means evolved to offset these difficulties in titanium melting apply equally to zirconium. I.C.I. Metals Division, with nine years' research, development and production experience on titanium to its credit, had surprisingly little difficulty with zirconium, which achieved commercial production in 1958. Ingots weighing half a ton are regularly produced by the consumable electrode vacuum arc-melting process; if required, ingots weighing up to 3 tons can be produced in Europe's largest zirconium melting plant.

Ingots are converted into wrought forms—strip, sheet, plate, rod, tube and wire—by conventional processes, though precautions must be taken to avoid contamination during hot working and annealing, particularly by nitrogen, which impairs corrosion resistance. For thin sections, vacuum annealing methods are preferred.

Applications of beryllium, titanium and zirconium

Apart from small quantities used in *x*-ray windows, the main outlet for beryllium has so far been for reflectors in atomic reactors. The metal is also potentially interesting to aircraft engineers because of its combination of low density and high elastic modulus; reports indicate that it has already been used in the United States for components of high-speed aircraft, guided missiles and guidance systems.

Because of its comparative scarcity and the elaborate techniques involved at all stages of production, beryllium is inevitably an expensive metal. Raw beryllium costs about £20/lb. and the present quoted world price for wrought beryllium is about £160/lb. Even at this level (less than half the price of platinum), use of beryllium can be justified where its properties offer unique technical advantages. As increasing demand and/or technological improvements reduce the price, its potential as an important new engineering material will be more clearly seen.

Titanium, whose attractive strength/weight ratio makes it especially useful in the aircraft industry, was initially produced with the needs of that industry in mind. But its outstanding resistance to corrosion and erosion has also brought it to the attention of chemical engineers for service in a wide range of aggressive media. Numerous previous articles and notes in CHEMICAL & PROCESS ENGINEERING have reported on the use of titanium for complete chemical plant components, for lining vessels and for anodes in electrochemical processes. Titanium and some of its alloys, having an extremely short 'half-life,' can also be used for certain components in nuclear reactors, such as handling gear and control rod sheaths.

Zirconium has few uses outside nuclear engineering at present, but as a highly corrosion-resistant material it has been used for lined vessels, pump and valve components, agitators, thermocouple pockets and other items of chemical plant.

Carbon brushes for electrical machines. A new booklet gives an account of the manufacture of brushes, brush grades, construction and mounting. It deals with the ordering of brushes, troubles and their causes, brush holders and accessories. Copies available from the Morgan Crucible Co. Ltd., Battersea Church Road, London, S.W.11.

Technology Notebook

Isotopes

After eight years at Harwell, the A.E.R.E.'s Isotope School has now been established in new buildings at the Wantage radiation laboratory.

The purpose of the school is still to give practical and theoretical instruction in the use and safe handling of radioisotopes, but its scope has widened since its inception. The 1960 programme includes five general courses and two short courses in radiological protection. As well as this, advanced lectures in chemistry and radiobiochemistry are planned and there is to be a special series for analytical chemists and water chemists.

Distillation

The International Symposium on Distillation is to be held at Brighton on May 4, 5 and 6 as a meeting of the European Federation of Chemical Engineering. The preliminary programme contains 29 papers from experts on distillation in nine countries. The organisers, the Institution of Chemical Engineers and the Chemical Engineering Group of the Society of Chemical Industry, have selected from the papers offered those which give the greatest promise of revealing original information applicable in a wide field. The meeting will be conducted in English, French and German, and simultaneous translation will be provided.

Enquiries to: The General Secretary, Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1.

Heat transfer

The mechanical engineering department at the University of Florida will hold its annual Heat Transfer Symposium on March 7 and 8. Several sessions are planned to include basic principles, temperature and its measurement, heat exchangers, graphical methods, the hydraulic analogue and other selected topics.

Information from Prof. J. C. Reed, Head, Mechanical Engineering Department.

Instruments and measurements

The fifth International Instruments and Measurements Conference will be held in Stockholm, Sweden, September 13 to 15, 1960. It is organised by the Royal Swedish Academy of Engineering Sciences and the Swedish Association of Technical Physicists and will be divided into four sections: automatic process control, physical methods for chemical analysis, nuclear instrumentation, and measurements of electric and magnetic quantities.

Welded structures

The British Welding Research Association and the Engineering department of Cambridge University are jointly organising a symposium on ' Fatigue of Welded Structures,' to be held in the University from March 29 to April 1, 1960.

It will include contributions from the U.S.A. and from East Germany. These will deal primarily with structures fabricated by fusion welding processes.

Details from the British Welding Research Association, Abington Hall, Abington, Cambs.

Industrial Publications

Sponge iron. The *HyL* process for converting iron ore into sponge iron is described in a brochure by the M.W. Kellogg Co., which is based on operating data from a 200-tons/day plant in Mexico. This plant proves the process commercially successful by producing a sponge iron that is used in place of pig iron or scrap in the making of high-quality steel. As well as describing the process in detail, the brochure has tables showing ore analysis, sponge iron analysis, estimated utility costs for a 500-tons/day plant, and estimated operating costs for a 1,000-tons/day plant. Copies from the company, 711 Third Avenue, New York 17, N.Y.

Rubber compounds. As a result of research work carried out by the British Rubber Producers' Research Association, the usage of natural rubber can now be extended to include products for service at temperatures of the order of 100 to 125°C. Full details of the compounding methods and ingredients, together with test results, are given in Technical Bulletin No. 3, available from the Natural Rubber Development Board, Market Buildings, Mark Lane, London, E.C.3.

Laboratory ware. From Loughborough Glass Co. Ltd., Loughborough, Leics., comes a catalogue covering a range of laboratory apparatus. It is divided into three parts, each arranged alphabetically, covering: (i) ground-joint interchangeable laboratory glassware; (ii) plastic laboratory equipment, including a number of new products recently developed; and (iii) general equipment such as beakers, crucibles, bottles, etc., in a variety of materials.

Engineering and construction. A case history of the contractual, engineering and construction decisions made by British American Oil Co. Ltd. and Canadian Kellogg Co. Ltd., resulting in B.A.'s new Port Moody refinery in record time and at low cost, is presented in a new publication by Kellogg.

The brochure traces the month-by-month development of the 20,000-bbl./short day project in diary, photo and chart form. This latest issue of the *Kelloggram* publication is available from the M.W. Kellogg Co., 711 Third Avenue, New York, N.Y., or the Canadian Kellogg Co. Ltd., 33 Bloor Street East, Toronto 5, Canada.

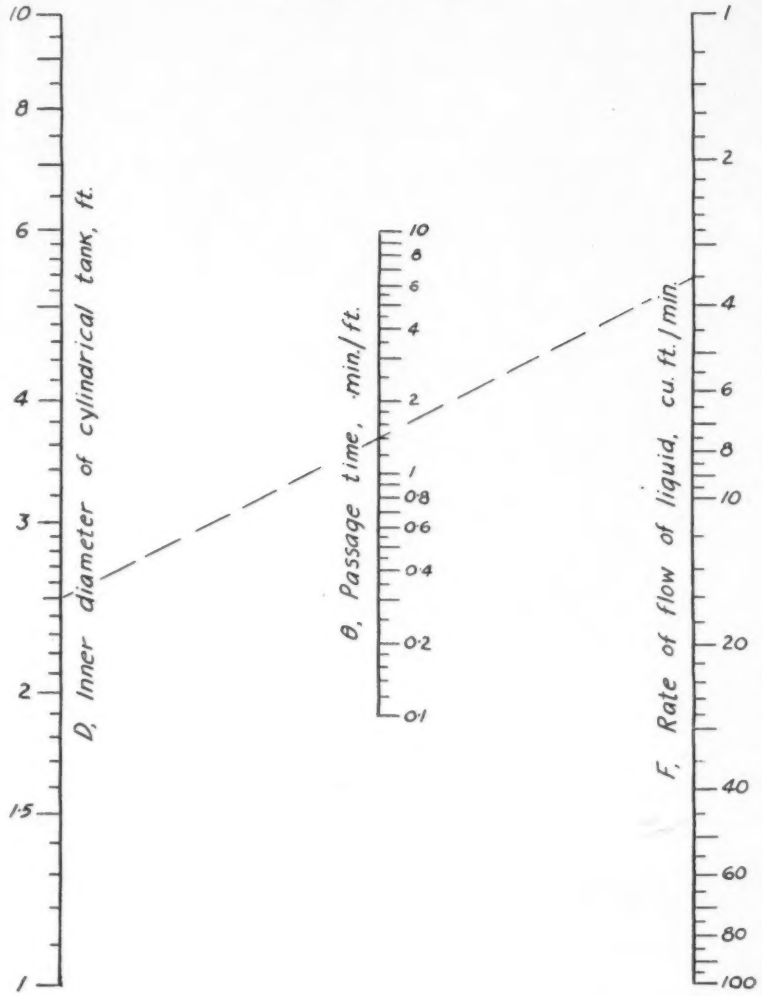
Sulphuric acid. A new brochure by Chemical Construction (G.B.) Ltd. is designed to allow manufacturers to select any one of 750 variations obtainable for sulphur-burning sulphuric acid plants. It features a pictorial flowsheet employing a number of flaps and makes selection easier for the non-technical as well as the technical man. The company's address is 9 Henrietta Place, London, W.1.

Comical Engineering Corner

"IT'S THE DISINTEGRATOR — IT DISINTEGRATED!"

Passage Times for Liquids in Cylindrical Tanks

By D. S. Davis
(*University of Alabama*)



Chemical engineers are often interested in knowing the passage time, θ, in minutes per foot, for a liquid flowing through a cylindrical tank of inner diameter D feet at a rate of F cu.ft./min. These variables are related by the equation

$$\theta = \frac{\pi D^2}{4F}$$

which is the basis for the accompanying nomogram, constructed by means of methods described previously.[1]

The broken index line shows that the passage time is 1.40 min./ft. when 3.50 cu.ft./min. flow through a cylindrical tank that has an inner diameter of 2.50 ft.

Need for such a nomogram was incidentally suggested by Knapp.[2]

REFERENCES

[1]D. S. Davis, 'Nomography and Empirical Equations,' Chap. 6. Reinhold Publishing Corporation, New York, 1955.

[2]W. J. Knapp, *Chem. Eng.*, 1959, **66** (19), 168.

New Books

Plastic properties of steel sections

This new work of reference* on the plastic moduli of steel joists, beams and channels was compiled by Dr. M. R. Horne in the course of work on the plastic theory of structures being carried out at the engineering department, University of Cambridge. It deals with the plastic moduli, with and without load, of British Standard rolled-steel joists, British broad-flanged beam sections, British Standard channels and special channels. A further section is devoted to the properties of British Standard equal and unequal angles.

There are fully explained tables and algebraic expressions for the various properties quoted, with details of their derivation in three appendices.

**The Plastic Properties of Rolled Sections.* British Welding Research Association, Abington, Cambs., 1959. Pp. 55, illus., 8s. 6d.

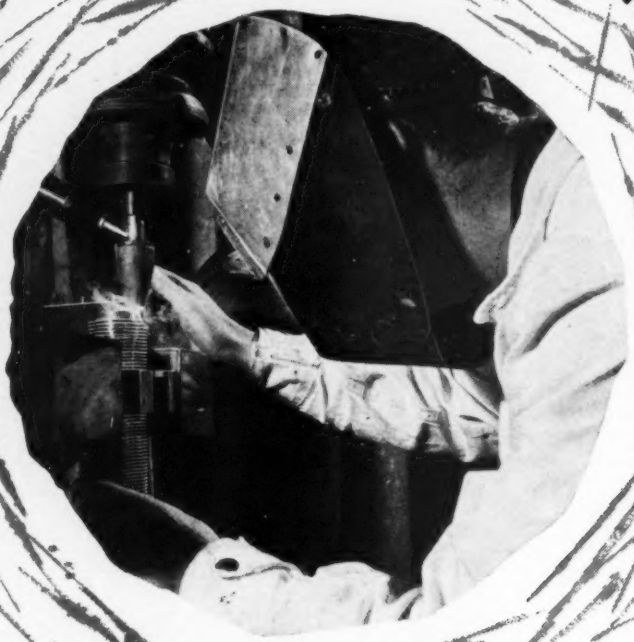
Aspects of nuclear technology

The author of this book,* a physicist with wide experience in the design of boilers and steam-raising plant, has excellent qualifications for writing a work of such wide content and scope. The chemist, the chemical engineer, the physicist, and the metallurgist—each will find something new in his own field, and get to know and appreciate the problems of his colleagues. It is not a specialist work, but is aimed at supplying the nuclear specialist with a broad survey of the various fields involved in the technology of nuclear power production.

After an introductory section dealing with the basic physics of elementary particles, nuclear properties and stability, radioactivity, nuclear and chain reactions, their production and potential as energy sources, the author covers the general principles of reactor theory and construction. He deals adequately with constructional, shielding, and coolant materials, heat production cycles, heat exchangers and thermodynamics. A final section is devoted to the periodic table, the special features of the lanthanides and actinides, and the chemical technology of fuel elements.

If any criticism of the book is possible, it is that this volume has no

LIGHT ALLOYS in nuclear research and development



Birmetals

Light alloys in all wrought forms

The large scale production of the special magnesium alloy used to make the fuel element cans for Calder Hall was the result of collaborative experimental work by Birmetals Limited and the United Kingdom Atomic Energy Authority.

Similar collaboration between Birmetals, the U.K.A.E.A. and the commercial constructors of nuclear power plants is ensuring continued development in this and other allied metallurgical fields.

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BM 221

index. It may be argued that an index in Vol. 2 is sufficient, but Vol. 1 is such an invaluable book in its own right that a separate index would be justifiable.

This book can be recommended as an invaluable addition to the library of every nuclear scientist.

**Nutzenergie aus Atomkernen*, Vol. 1, by Dr. Karl R. Schmidt. Walter der Gruyter & Co., Berlin. Pp. 592, DM. 106.

Elastic and plastic phenomena

A standard treatise on the rheological aspects of such technically important solids as crystals, resins, textiles, rubber and clay has appeared.* The first part of the book covers general physical and mathematical aspects of plasticity, elasticity and viscosity. The author combines the findings of physics and chemistry in an examination of such topics as deformations, internal structure of matter in relation to elastic and plastic behaviour and formation of solid matter from a fluid. A special 55-page chapter by Dr. W. G. Burgers summarises the recent work on crystal flow.

The author's interest is in the deliberate synthesis of materials with predicted desired properties. Having derived a body of principles in the earlier chapters, he applies them to common processes involving substances such as glass, rubber, paints and lacquers.

**Elasticity, Plasticity and the Structure of Matter*, by R. Houwink. Dover Publications Inc., New York, 1959. Available from Constable & Co., London. Pp. 368, 20s.

Liquid-liquid extraction

The second edition* of a book which originally appeared in 1954 as the first one to concentrate mainly on the practical aspects of liquid - liquid extraction has now appeared. In scope, the book remains essentially the same but the contents, particularly the chapters on single-solvent countercurrent extraction, two-solvent countercurrent extraction, and reflux in extraction processes, have been changed considerably. The theory dealt with in these chapters is now based on a new method of calculation developed recently by Mr. J. Groot Wassink in close co-operation with the author.

A number of other improvements have been introduced; for instance, a more complete survey of the methods of interpolation of tie lines and the estimation of the plait point, and of the construction methods for the derivation of extraction results in single-solvent countercurrent extractions. The treatment of accumulation and of the approach to steady-state conditions have been extended, while the use of regenerated solvents is given a quantitative treatment. Other important improvements are concerned with the application of wash solvent in a part of a two-solvent process only; a discussion of the Craig distribution method; and the use of combinations of separating units.

Although the book is primarily a practical one, the theory behind the practice is not neglected. The theory of phase equilibria is dealt with in so far as these may be encountered in extraction problems. The experimental procedures that furnish the data required for extraction calculations are described. The author then goes on to discuss the mathematical solutions of extraction problems and the theories on which they are based. Finally, he describes laboratory-scale operations that can be carried out to obtain information about the results that may be expected in industrial extraction processes.

A survey is given of the principal extraction procedures, and the merits and demerits of each of the processes are discussed. The derivation and and application of the formulae for each of the processes are given; with the aid of these, extraction results can be predicted. Many of the formulae are new and have not yet been published elsewhere.

**Liquid-Liquid Extraction*, by L. Alders, 2nd edition. Elsevier Publishing Co., London, 1959. Available from D. Van Nostrand Co. Ltd. Pp. 209, illus., 42s. 6d.

BOOKSHOP SERVICE

All books reviewed in CHEMICAL & PROCESS ENGINEERING and all other scientific or technical books may be obtained from:

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London, N.W.1.
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★ Fisons Ltd. have announced that, in view of the importance which is attached to research, the board has elected **Mr. C. E. Horton,** C.B.E., to be a vice-chairman of the company. He has been research director since 1951. From 1943 to 1945 he was Assistant Director of Scientific Research at the Admiralty and was later appointed Director of Physical Research.

★ Personal Paragraphs ★

★ **Sir Owen Wansbrough-Jones,** K.B.E., C.B.E., has been appointed a director of the British Oxygen Co. Ltd. Trained as a physical chemist, Sir Owen took first classes in both parts of the Natural Science Tripos at Cambridge. He studied various aspects of surface chemistry and was for a while principal assistant to Sir Eric Rideal, F.R.S., in the laboratory of colloid science, later becoming tutor of his own college, Trinity Hall. During the war Sir Owen worked on chemical warfare and a variety of scientific and technical matters. On demobilisation he was invited to become Scientific Adviser to the Army Council. In 1950 he transferred to the Ministry of Supply as Director General of Scientific Research in respect of Army requirements and two years later was promoted to Chief Scientist.

Sir Owen Wansbrough-Jones.

★ **Herr W. Mey** has been appointed general manager of the German subsidiary company of Q.V.F. Ltd., Q.V.F. Glastechnik. Previously commercial manager, he has been with the company since its inception in 1956.

★ **Mr. G. P. Davidson** has been appointed managing director of Head Wrightson Processes Ltd. with effect from February 1. The board has retained the services of **Dr. R. C. Fisher** who will act as adviser on nuclear projects.

★ **Dr. W. G. Hiscock** has been appointed chairman of the Lead Development Association for 1960.

World News

UNITED STATES

More ethylene

Plans to expand facilities at SunOlin Chemical Co. in North Claymont, Del. (see article, CHEMICAL & PROCESS ENGINEERING, 1959, **40** (9), 333), to include the manufacture of ethylene, were announced by J. I. Harper, president of SunOlin. The new plant will cost about $15 million.

Final capacity will be nearly 200 million lb. p.a. A portion of the ethylene will be converted to ethylene oxide and glycol to meet developing needs on the east coast.

Dry gas from Sun Oil's Marcus Hook, Pa., refinery will be used for the production of ethylene. The plant, which is adjacent to Sun's refinery, is located at the focal point of the Delaware valley—a fast-growing chemical centre with large industrial tracts still available. This new source of olefines, in the heart of the second largest petroleum refining centre in the U.S., is important to producers of plastics and resins and major users can be served by pipeline.

SunOlin is an equally owned affiliate of Sun Oil Co. and Olin Mathieson Chemical Corporation.

POLAND

Polyester fibre

The factory for the manufacture of polyester fibre, under licence, recently purchased from I.C.I., is to be at Torun and will come into production in 1963.

INDIA

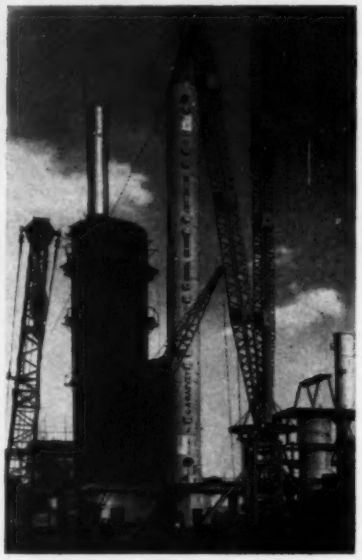
Fertiliser plant

An Italian firm, Ansaldo, in association with Montecatini and two West German firms, Pintsch-Bamag and Linde, have signed agreements with the Neyveli Lignite Corporation for the design, fabrication of equipment, erection and starting of a fertiliser plant at Neyveli with a capacity of 152,000 tons p.a.

CEYLON

Fertilisers

Mr. E. C. S. Paul, the Director of Industries, while attending the G.A.T.T. conference in Tokyo, held talks with the Japanese Government on the possibility of Japanese co-operation in the building of a chemical fertiliser plant at a cost of about Rs. 100 million. The plant to be erected must be capable of producing 200,000 tons of ammonium sulphate p.a.



CARBON DIOXIDE ABSORBERS

At the South Eastern Gas Board's Isle of Grain works the first of the carbon dioxide absorbers for the high-pressure oil gasification plant has just been lifted into position. The vessel, which is itself 120 *ft. high and weighs some* 100 *tons, was raised by a guy derrick with a* 133*-ft.-long jib and then lifted and lowered on to its raised plinth foundation within* $\frac{1}{16}$ *in.*

Woodall-Duckham Construction Co. Ltd., the main contractors, will erect a second absorber within a few weeks and the complete plant should be ready this year.

PERU

Nitroglycerine

Explosivos S.A. have inaugurated a new plant for the manufacture of nitroglycerine at their factory near Lurin. The plant has a capacity of 500 kilos/hr. and will use materials supplied by Fertilizantes Sinteticos S.A.

CHINA

Sulphuric acid plants in operation

Two new sulphuric acid plants have gone into operation in Hangchow and Ningpo, Chekiang Province. Together they can produce 10,000 tons of acid p.a. The Shanghai Chemical Industry Research Institute has set up a sulphuric acid plant with capacity of 4,000 tons p.a. The Szechwan chemical works has begun to produce chemical fertiliser and is expected to turn out 10,000 tons of ammonium sulphate by the end of the year. A polyvinyl benzol workshop has begun production at the Kaochiao chemical works.

COSTA RICA

Fertilisers

A plant has been projected in Costa Rica at a cost of U.S. $7 million, capable of producing 440 tons/day. The International Development & Investment Co., the Chemical & Industrial Corporation of Cincinnati (who specialise in the design and construction of plants for the preparation of ammonia) and the Phoenix Rheinrohr, of Düsseldorf (who are to supply the machinery), are reported to be participating in the project. The Compania Financiera Agricola Industrial S.A., formed by a group of Costa Rican and other Central American capitalists, would subscribe 60% of the required capital and the remaining 40% would be subscribed by the foreign group mentioned in the report.

BRITISH EAST AFRICA

New oil refinery

Work is to begin this year on a £15-million oil refinery to be built at Changamwe, near Mombasa, by the Shell Co. of East Africa and B.P. (East Africa) Ltd. The refinery will be of sufficient capacity to 'take care of' the total East African requirements of petroleum products. These are now 1.25 million tons p.a. By 1963 they are expected to rise to 1.4 million tons. The bulk of the crude oil will be imported from the Persian Gulf area and refined products will include petrol kerosene, aviation turbine fuel, gas oil and diesel fuel, but not bitumen.

Of interest to our readers . . .

A number of articles appearing in our associate journals this month will appeal to readers of CHEMICAL & PROCESS ENGINEERING.

The Manufacturing Chemist includes an article on drying plant by E. N. Simons, the purity of analytical reagents is discussed by J. T. Yardley, while the second part of an article on the polyols, by Dr. Greville Machell, also appears.

Paint Manufacture has an article on the high-boiling solvents for nitrocellulose lacquers and another on the function of paint solvents.

Food Manufacture. There is a review of grinding and milling machinery.

Petroleum contains a safety and fire equipment review, an article on the Shell Haven chemical fertiliser plant and one on petrochemicals at Grangemouth.

Fibres and Plastics. Reinforced epoxide pipes is the subject of one article.